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ABSTRACT

This assessment was designed to evaluate students' achievement in and attitude toward mathematics, document changes in achievement by comparing the 1981 results to those obtained in 1977, and survey teachers of mathematics. The assessment was also directed toward identifying and clarifying different models for the mathematics curriculum. This second provincial assessment was carried out with over 90,000 pupils from grades 4, 8, and 12, and a sample of 2,500 tenth graders. These pupils were assessed on mastery of: Number and Operation, Geometry, Measurement, Algebraic Topics, and Computer Literacy. Pupil attitudes were also surveyed. Overall achievement was considered encouraging, with Measurement a concern as it consistently had the lowest rating. Two teacher questionnaires were developed for the assessment, and teachers were randomly selected from grades 1 through 12 to respond. Responses indicated many mathematics classes are taught by instructors with little professional or academic preparation, particularly at the junior secondary level. Ten appendices contain items and details related to the assessment. (MP)

BRITISH COLUMBIA MATHEMATICS ASSESSMENT 1981

The 1981 B.C. Mathematics Assessment

GENERAL REPORT

David F. Robitaille, Editor

Submitted to the
Learning Assessment Branch
Ministry of Education

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THE 1981 B.C. MATHEMATICS ASSESSMENT

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PREFACE

This General Report of the 1981 B. C. Mathematics Assessment contains a description of the study, an analysis of the major findings, and a number of recommendations directed toward those who share in the continuing task of improving the teaching and learning of mathematics in this province. The Assessment was designed to evaluate students' achievement in and attitude toward mathematics, to document changes in achievement by comparing the 1981 results to those obtained in 1977, and to conduct a survey of teachers of mathematics. In addition, the entire Assessment has been directed toward the goal of identifying and clarifying different models for the mathematics curriculum.

The report, like the proof of a mathematical theorem, conceals most of the time and effort that went into the planning and execution of the study. In all, the students and the teachers of mathematics, the personnel of the Learning Assessment Branch of the Ministry of Education, the staff of B. C. Research, and the members of the Contract Team, the Advisory Committee, and the Review Panels spent over 90 000 hours on the project--more hours than the average person works in a lifetime.

To the teachers of mathematics and their principals I would like to extend my thanks for the level of professionalism they exhibited by their willingness to participate in the various phases of the study. Special thanks are also due to a number of individuals whose expertise and dedication helped make what could have been a virtually impossible task into a rewarding, professional experience. This group includes Nancy Greer, Bob Wilson, and Alan Taylor of the Learning Assessment Branch as well as Mary Cooper and Barbara Holmes of B. C. Research, and Mike Dirks of U. B. C., my Research Assistant.

Finally, my thanks go to the members of the Contract Team for the fine work they did on the project. For each of them this meant adding an onerous task to already-overcrowded schedules, with little prospect of any reward other than their personal satisfaction. Wendy Klassen, Ian de Groot, Les Dukowski, Tom O'Shea, and James Sherrill gave unselfishly of their time and talent to assure the success of the 1981 Mathematics Assessment.

David F. Robitaille
University of B. C.

CHAPTER 1

INTRODUCTION

David F. Robitaille

The second British Columbia Mathematics Assessment was carried out during the 1980-81 school year. Approximately 90 000 students[1] enrolled in Grades 4, 8, and 12 throughout the province, as well as a representative sample of Grade 10 students, took part in the study which was conducted on behalf of the Learning Assessment Branch of the Ministry of Education by a Contract Team which had been selected for that purpose. In addition, approximately 1600 teachers of mathematics completed questionnaires which dealt with a number of important aspects of the teaching and learning of mathematics.

With this Assessment the Learning Assessment Branch implemented, for the first time, a policy which stipulated that, in a given school year, no school would be requested to have its students participate in more than one activity related to the Mathematics Assessment and one other project sponsored by the Learning Assessment Branch. As a result, all of the students in any school which took part in the formal pilot-testing of the instruments were excluded from the Assessment itself which took place in the month of March. A second policy implemented in this project called for having a sample of students within sufficiently large districts participate rather than the entire population. The possibility of implementing that policy had to be decided separately for each school district since, in order to produce reliable data for the district reports[2], fairly large numbers of students had to be included. Details of the sampling techniques employed are presented in Chapter 4.

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[1]This number includes students from the public schools of the province and from independent schools receiving financial support from the Ministry of Education. The data reported in the remainder of this report are based solely on the information obtained from teachers and students in the public schools.

[2]Each of the 75 school districts in the province receives a District Report of the Assessment results. That report includes the item results for their own students as well as the corresponding figures for the province as a whole and their geographic zone.

1.1 Organization of the Assessment

A number of different groups participated in the design and execution of the 1981 Mathematics Assessment. In addition to the thousands of teachers and students who completed the Assessment instruments, these included personnel from the Learning Assessment Branch of the Ministry of Education, the members of the Contract Team, representatives from B. C. Research, as well as the members of the Technical Sub-Committee, the Advisory Committee, the Review Panels, the Interpretation Panels, and the teachers and students of the schools which participated in the pilot-testing.

The Contract Team had the primary responsibility for designing the Assessment, developing the necessary instrumentation, and reporting the results. The team was composed of two members of the Department of Mathematics and Science Education of the University of British Columbia, a member of the Faculty of Education of Simon Fraser University, and three classroom teachers: a primary teacher from Richmond School District, a junior secondary teacher from Langley, and a senior secondary teacher from North Vancouver.

B. C. Research served as the Technical Agency for the Assessment. B. C. Research is the technical operation of the British Columbia Research Council, an independent, non-profit, industrial research society. B. C. Research carries out contract research and provides technical services to clients in the private and public sectors. As the Technical Agency for the Assessment, B. C. Research was responsible for various parts of the project such as overseeing the printing, distribution, and collection of the instruments, coordinating the scoring and analysis of all of the instruments, and providing consultative services to the Learning Assessment Branch and the Contract Team on matters relating to the technical, statistical, and psychometric aspects of the study.

The Technical Sub-Committee consisted of representatives of the Learning Assessment Branch, the Contract Team, and the Technical Agency. This committee served as the forum for discussion and decision-making on issues of a technical or statistical nature.

The Advisory Committee provided guidance and advice to the Contract Team and the Ministry of Education during the development of the instruments, the review of the results, and the preparation of the final reports. They also chaired the meetings of the Review Panels and of the Interpretation Panels.

The members of the Advisory Committee were selected from across the province by the Learning Assessment Branch to reflect a cross-section of opinion on matters pertaining to the teaching and learning of mathematics. In addition to two representatives of the Learning Assessment Branch, the chairman of the Contract Team, and two representatives from B. C. Research, the Advisory Committee consisted of four classroom teachers, a school principal, a district-level administrator, a university professor, and a school trustee.

Like the Advisory Committee, the Review Panels and the Interpretation Panels consisted of educators and informed members of the public selected from across the province. The task of the Review Panels was to discuss the goals and objectives of the mathematics curriculum in B. C., both present and future. The Interpretation Panels were convened after the Assessment data had been analyzed to examine the results and to comment on the performance of the students.

1.2 Scope of the Assessment

The Learning Assessment Program is based on the premise that systematic collection and dissemination of comprehensive, reliable data are essential components of the effective management of education in this province. Decisions about new directions or new emphases in educational matters should be based on a clear understanding of what students are learning and how they are being taught.

According to guidelines laid down by the Learning Assessment Branch, the objectives of each province-wide assessment are to:

- inform professionals and the public of the strengths and weaknesses of the public school system;
- assist the Ministry and school districts in decisions related to the development, review, modification, revision, and implementation of existing curricula and supporting instructional materials;
- assist the Ministry in decisions concerning allocation of resources;
- identify areas of need and provide directions for change in both pre-service and in-service teacher education and professional development;

- provide direction for educational research.

Within the framework of these guidelines, it was intended that the 1981 Mathematics Assessment would provide the Ministry of Education with much of the information required to make decisions about the need for a review or revision of the current mathematics curriculum, and about directions that any such process might take. Five specific goals were established:

- to identify the major curriculum models in use in British Columbia and elsewhere;
- to evaluate and report on students' achievement in mathematics and their attitudes toward the subject;
- to assess the extent and direction of change in the pattern of students' achievement since the 1977 Assessment;
- to survey teachers of mathematics on a number of matters which affect the teaching and learning of mathematics;
- to co-ordinate B. C. participation in the Second International Study of Mathematics.

Curriculum Models

Wherever mathematics . taught, the curriculum is based on a particular set of opini and beliefs about the nature of mathematics and its place in general education. These opinions and beliefs, whether stated explicitly or not, help to determine the content of the mathematics curriculum and the methodology used to teach that content. An attempt was made in this Assessment to categorize such opinion and beliefs, to identify a number of alternative models for the mathematics curriculum, and to solicit opinions from educators and members of the public regarding the goals of the mathematics curriculum in B. C., both present and future.

As a first step, a paper entitled Curriculum Models in Mathematics was written. Its purpose was to identify widely-held points-of-view about the nature of mathematics, the characteristics of different mathematics curr ula, and a number of factors which influence those curricu . The paper was intended to serve not only as a framework for designing the instrumentation to be used in the Assessment and for analyzing the results, but also as a background paper for any future review or revision of the mathematics curriculum in the province.

Secondly, meetings were held with six Review Panels at four locations around the province. Each person who was invited to one of these meetings was sent a copy of the Curriculum Models paper and a Goals Survey questionnaire which had been designed to gather information about goals for the mathematics curriculum.

The opinions of teachers of mathematics were also sought on the questions of curriculum models and goals of the mathematics curriculum. Certain sections of the Goals Survey questionnaire were reproduced on the Teacher Questionnaires, thereby enabling teachers to express their views on some of the same matters as the Review Panels.

Student Outcomes

A major objective of every assessment is to evaluate student attainment in a particular discipline. In the 1981 Mathematics Assessment this was done by selecting five relatively broad areas, called domains, for evaluation. At each of the grade levels where testing was done, the same five domains were utilized: Number and Operation, Geometry, Measurement, Algebraic Topics, and Computer Literacy. Each domain, except Computer Literacy, was subdivided into a number of objectives. Test items corresponding to these domains and objectives were developed by the Contract Team during the summer of 1980, pilot-tested in the fall, and then selected for inclusion on the Assessment instruments. The final pool of cognitive test items at the Grade 4 level consisted of 138 items divided equally among three booklets. For Grade 8 also, there were 138 items divided among three booklets; for Grade 12, 90 items divided into two booklets.[3]

Within each domain and objective, efforts were made to include items which not only tested the specific topic in question, but also required students to use different types of skills and abilities in order to obtain the solutions. Using a classification scheme adapted from Wilson (1971) which had also been used in the 1977 Mathematics Assessment (Robitaille and Sherrill, 1977) as well as in a test-development project sponsored by the Learning Assessment Branch (Robitaille, Sherrill, and O'Shea, 1980), each item was categorized as belonging to one of three cognitive behavior levels: Computation and Knowledge, Comprehension, and Application. Items were also

[3]Because so many school districts have few Grade 12 students, the numbers of items and test booklets at that level had to be restricted in order to provide reliable estimates of student achievement at the district level.

selected on varying levels of difficulty, as defined by the results of the pilot-testing.

As was the case in 1977, the 1981 Assessment was directed primarily at three groups of students: Grade 4, Grade 8, and Grade 12. These three groups were selected to represent, respectively, the end of primary education, the end of elementary education, and the end of public schooling[4]. In addition, a probability sample of Grade 10 mathematics classes participated in the Assessment. Their participation was intended to provide information on student attainment of the content objectives evaluated in the Assessment at that point in the curriculum, namely Grade 10, where the study of mathematics ceases to be compulsory. Moreover, their participation provided data for comparison with the Grade 12 population as a whole and, more importantly, with that portion of the Grade 12 population which had not studied any mathematics beyond the Grade 10 level.

The structure of the cognitive item pool for the Assessment is shown in Figure 1-1. The model is a 5 X 3 X 3 solid: five content domains, three cognitive behavior levels, and three grade levels.

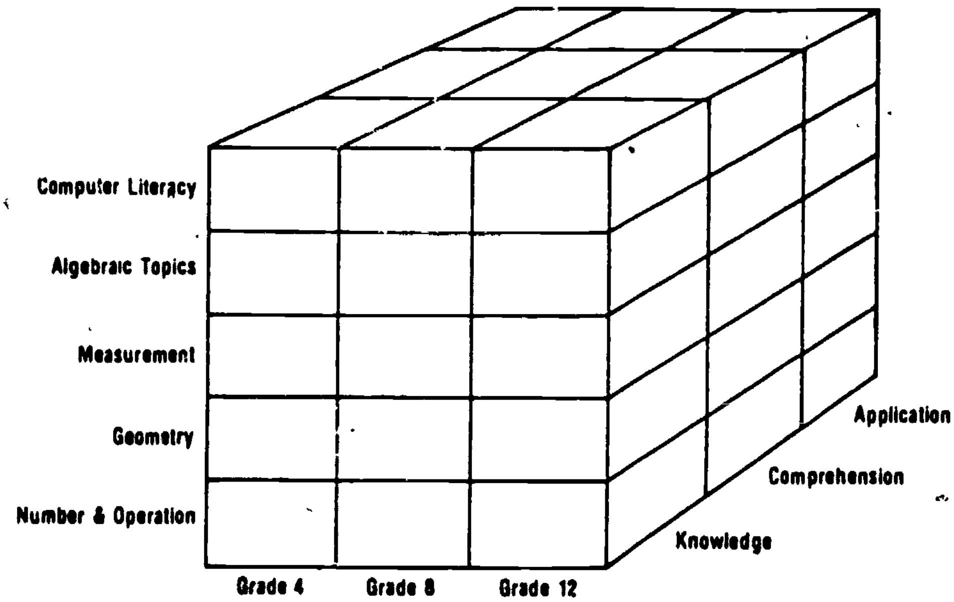

Figure 1-1. Model for the 1981 Mathematics Assessment.

[4]All Grade 12 students were included whether they were studying mathematics or not.

The content objectives which were assessed at each grade level included a small number that are not part of the present B. C. mathematics curriculum. For example, none of the content included in the Computer Literacy domain is listed in the current edition of the B. C. curriculum guide for mathematics (Curriculum Development Branch, 1978). Similarly, objectives dealing with basic ideas from the fields of probability and statistics were included in the Assessment even though these topics are not part of the prescribed curriculum. Inclusion of such non-curricular items and objectives was motivated by the fact that recommendations for including these topics in the school curriculum have been made by groups such as the National Council of Supervisors of Mathematics (1978) and the National Council of Teachers of Mathematics (1980). These topics were also among the ones evaluated in the 1978 assessment of mathematics conducted in the United States by the National Assessment of Educational Progress (NAEP,1978).

A number of the items used in the Assessment were chosen from among those used in the 1977 Assessment as a means of assessing the extent and direction of change in students' achievement patterns since the first study. These items were collected into groupings called Change Categories. There were two Change Categories at the Grade 4 level (Number and Operation, Measurement), two at Grade 8 (Number and Operation, Geometry and Measurement), and three at Grade 12 (Number and Operation, Geometry and Measurement, Algebra).

Student outcomes in mathematics consist of more than just achievement. Students develop ideas about the nature of the subject and attitudes toward it. In an attempt to obtain some data from students about their feelings toward mathematics, an attitude scale was included as part of the student test booklets at each level tested. The items making up that scale were selected from among those used in the most recent NAEP assessment of mathematics and in the Second International Study of Mathematics.

Teacher Survey

Probability samples of teachers of mathematics at all grade levels were identified as prospective participants in this phase of the study. Each of those teachers was sent a comprehensive questionnaire, some thirty pages in length. Of the more than 2100 questionnaires which were sent out, 75% were returned completed: an extremely high rate of return for such a lengthy questionnaire distributed by mail.

The questionnaires, one form for elementary teachers and another for secondary, were divided into eight sections. The first section dealt with the teacher's background and academic preparation. The remaining sections treated topics such as

goals of mathematics education, implementation of the prescribed curriculum, utilization of calculators and computers, impact of the Learning Assessment Program, teacher education in the future, some class-specific information, and current practices in the teaching of mathematics.

Second International Study of Mathematics

Strictly speaking, the International Study was not part of the 1981 Assessment; however, both projects took place during the 1980-81 school year and B. C. participation in both was sponsored by the Learning Assessment Branch. The results obtained from B. C. participation in the International Study are the subject of a separate volume to be published by the Ministry of Education early in 1982. Only a brief description of the structure of the study is given here.

The International Study is being conducted by the International Association for the Evaluation of Educational Achievement, better known as IEA. IEA has sponsored a number of international surveys on various subjects, including the First International Study of Mathematics (Husén, 1967) which was conducted approximately fifteen years ago. Twelve countries, not including Canada, participated in that study.

As with the first study, the Second International Study of Mathematics is focussed on two groups of students and their teachers. For British Columbia the first group, known as Population A, consists of students enrolled in Math 8. The second group, Population B, consists of "students who are in the normally accepted terminal grade of the secondary education system and who are studying mathematics as a substantial part ... of their academic program". (IEA, 1979, page 10) In B. C. the sample for Population B was drawn from among those classes taking Algebra 12. In all, approximately one hundred Math 8 teachers and their students and an equal number of Algebra 12 teachers and their students made up the sample of classes selected to represent British Columbia in the study.

More than twenty jurisdictions are represented in the International Study. Most are countries, but there are some exceptions. A list of those participating is given below.

Australia	Israel
Belgium (Flemish)	Japan
Belgium (French)	Luxembourg
Canada (British Columbia)	Netherlands
Canada (Ontario)	New Zealand
Chile	Nigeria
England	Scotland
Finland	Spain
France	Swaziland

Hong Kong	Sweden
Hungary	Thailand
Ireland	United States

Components of the Study. The Second International Study of Mathematics has been structured as a broadly-based investigation of the teaching and learning of mathematics in schools. The project has three major components: a curriculum analysis, a study of classroom processes, and an analysis of student outcomes, both cognitive and affective, in the light of the curriculum and predominant instructional practices. The end-result will be the construction of an international portrait of the mathematics curriculum as intended and prescribed in curriculum guides and textbooks, as implemented by teachers of mathematics in their classrooms, and as attained by students.

Of the three components, the analysis of classroom process used in the teaching of mathematics was the one which most strongly motivated B. C. participation in the Study. A series of unique, topic-specific questionnaires, each dealing with a particular topic from the curriculum (e.g. Fractions, Measurement, Trigonometry) was developed as a means of gathering data on how teachers of mathematics go about the day-to-day task of teaching mathematics. The curriculum analysis component should also prove to be very useful since it will enable comparisons to be made between the B. C. mathematics curriculum and that offered in other parts of the world.

1.3 Structure of the Report

The topics covered in the remainder of this report fall into three main categories corresponding to the three major objectives of the 1981 Mathematics Assessment.

The first part, consisting of Chapters 2 and 3, deals with the topic of models for the mathematics curriculum. The Curriculum Models paper mentioned earlier appears here as Chapter 2. The three models defined therein will be referred to on a number of occasions in the remainder of the report. Chapter 3 contains a summary of the recommendations obtained from the Review Panels that participated in the Goals Survey.

The second section, Chapters 4 to 7, deals with student outcomes. Chapter 4 contains technical information about the structure of the instruments, the pilot-testing of the cognitive items and the attitude scale, as well as a discussion of the sampling procedures used. In Chapter 5, the results obtained at the Grade 4 level are presented. Chapters 6 and 7 contain the analogous information for Grade 8 and 12 students respectively. The Grade 10 results are also discussed in

Chapter 7.

The third portion, Chapters 8 and 9, is a report of the data obtained from teachers of mathematics. Chapter 8 contains a description of the background and academic preparation of the teachers as well as a summary of their opinions on a number of matters affecting the mathematics curriculum. Chapter 9 deals with the topic of instructional practices used by teachers in their teaching of mathematics.

The last chapter, Chapter 10, contains the recommendations which the Contract Team wishes to direct to those individuals, groups, and organizations who share the responsibility for the continuing improvement of the teaching and learning of mathematics in British Columbia.

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CHAPTER 2

CURRICULUM MODELS IN MATHEMATICS[1]

David F. Robitaille and Michael K. Dirks

Mathematics has always been a major component of the school curriculum. Mmari (1980) reminds us, for example, that Plato included mathematics as part of the training of the philosopher-king in The Republic. Although there are differences among countries regarding the specific mathematical topics that are included in the curriculum, in the proportion of students who study that content, and in the ways in which the content is taught, there is no disagreement regarding the basic fact of the matter. Mathematics is universally considered to be an important component of schooling.

A great deal has been written on the topics of goals for school mathematics and reasons for teaching mathematics. (See, for example, Ahlfors and others, 1962; Watson, 1971; Edwards, Nichols, and Sharpe, 1972; Braunfeld, Kaufman, and Haag, 1973; O'Brien, 1973; Bell, 1974; Evyatar, 1974; Hendrickson, 1974; Christiansen, 1975; Hershkowitz, Shami, and Rowan, 1975; Servais, 1975; Matthews, 1976; McNelis and Dunn, 1977). In the past decade Unesco has sponsored the publication of a number of reports entitled New Trends in Mathematics Teaching which deal with changes in the teaching of mathematics around the world. The most recent report, Volume IV, was published in 1979. Moreover, in 1978 Educational Studies in Mathematics published sixteen papers from different countries dealing with changes in the mathematics curriculum during the past twenty years.

In spite of the size of this body of literature, it is difficult to avoid concluding, as W. W. Sawyer (1948) does, that "the fact is that nobody knows why mathematics is taught in schools. Teaching mathematics is a custom, like shaking hands. We have got used to it. People cannot imagine schools without an arithmetic lesson." (page 8)

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[1]The authors are indebted to a number of people for their constructive criticism of earlier drafts of this paper. Among those who helped in this way were Tom Bates of UBC, David Wheeler of Concordia University, Ian Westbury of the University of Illinois, as well as the other members of the Contract Team and the Assessment Advisory Committee.

The allegation that no one knows why we teach the mathematics we do to so many students may be somewhat exaggerated, but it does contain a certain amount of truth. An examination of documents describing school mathematics curricula makes it appear that, in some cases, little thought has been given to fundamental issues such as the goals of the mathematics curriculum. Where goals have been identified it is often difficult to see how the content selected for inclusion in the curriculum is related to those goals. In certain instances it would seem that curricular goals are stated and then largely ignored. Content would appear to have been selected, as Sawyer says, on the basis of tradition or in response to the latest swing of the pendulum of curricular fashion.

Change in the mathematics curriculum is sometimes undertaken without sufficient prior consideration of goals and objectives. Such change seems pre-ordained to be transitory and not extremely influential. Successful adoption and implementation of a revised curriculum requires, as a prerequisite, careful weighing of the reasons for change and an in-depth evaluation of the goals of the curriculum. Alfred North Whitehead, the British philosopher, mathematician, and co-author with Bertrand Russell of the Principia Mathematica, addressed himself to the issue of change in the mathematics curriculum on the occasion of his presidential address to the Mathematical Association (Whitehead, 1916). In decrying the process by which such changes were introduced in a piecemeal fashion he said:

> This question of the degeneration of algebra into gibberish, both in word and in fact, affords a pathetic instance of the uselessness of reforming educational schedules without a clear conception of the attributes which you wish to evoke in the living minds of the children....
> You cannot put life into any schedule of general education unless you succeed in exhibiting its relation to some essential characteristic of all intelligent or emotional perception. (page 197)

More recently, in reporting the results of an observational study of the implementation of New Math curricula, Sarason (1971) commented as follows:

> The attempt to introduce a change into the school setting makes at least two assumptions: the change is desirable according to some set of values, and the intended outcomes are clear.... The new math ... illustrates the problem of intended outcomes clearly....

> Neither in the specific case we described nor in the general literature is it clear what outcomes were intended, whether or not there was a priority among outcomes, and what the relationship is between any outcome and the processes of change leading to it. (pages 62-63)

Regarding the process of curricular change, Sarason asserts that "intended consequences are rarely stated clearly, if at all, and as a result, a means to a goal becomes the goal itself, or it becomes the misleading criterion for judging change." (page 48)

The formulation of goals, the construction of a mathematics curriculum, and the successful implementation of that curriculum require an understanding of the nature of mathematics itself, of school mathematics, and of the interaction between the two. (See Figure 2-1) This interaction may be seen as consisting of a number of factors which operate on the body of mathematics to select and restructure the content deemed to be most appropriate for the school curriculum.

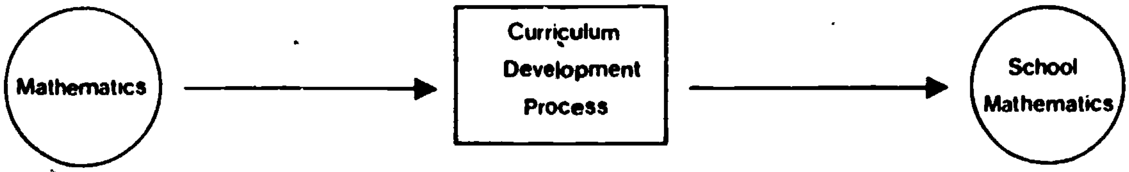

Figure 2-1. Origins of the school mathematics curriculum.

In the remainder of this chapter each of the three components will be examined in some detail. The nature of mathematics will be discussed first. This will be followed by an examination of four forces which affect and influence the curriculum development process. Then three curriculum models for mathematics will be described as outgrowths of the two earlier phases. Finally, some comments will be made concerning the implications of such an analysis for the process of curriculum revision.

2.1 The Nature of Mathematics

In a footnote to a paper dealing with aims of mathematics education, Watson (1971) says: "It has been conjectured that there exists an n_0 such that for $n > n_0$ any set of n mathematicians will contain at least one pair who disagree on the definition of mathematics. It is believed that $n_0=2$."[2] (page 106) As in the case of goals for the teaching of mathematics, there is a substantial body of literature dealing with the question of the nature of mathematics.

In this literature, there is virtual unanimity that mathematics is not monolithic, but multi-faceted. Beltzner, Coleman and Edwards (1976), in their review of the state of the mathematical sciences[3] in Canada, characterize the field in three ways: (1) as a powerful means for analyzing experience, (2) as a cultural resource, and (3) as an important language essential for modern communication. Furthermore, they propose as "the chief and overriding aim for the teaching of mathematics in the schools the widest possible dissemination of an understanding of what mathematics is and what it is not." (page 117) (emphasis in the original) They go on to say that, to their knowledge, such an aim has never been made explicit by any school system.

Many categorizations and partitionings of mathematics have been made over the years. It is commonplace, for example, to distinguish between pure and applied mathematics.

The historian of science, Thomas S. Kuhn (1977), provides some important insights confirming both the relatively recent emergence of the pure-applied distinction, and the divergence

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[2] A number of readers of an earlier draft of this paper have suggested strengthening Watson's conjecture by changing the condition to $n \geq n_0$. This new conjecture would appear to be founded upon a considerable amount of first-hand experience in the field.

[3] Steen (1978a) observes that "in the past quarter century the world of mathematics has evolved from a single discipline to a cluster of intertwined subjects now usually termed 'mathematical sciences'." (page 7) He lists as examples the fields of number theory, mathematical logic, differential topology, algebraic geometry, operations research, statistics, computer science, combinatorics, mathematical programming, mathematical economics, mathematical biology, mathematical psychology, mathematical linguistics, and cliometrics.

of opinion internationally regarding the exact nature of this distinction. He writes:

> A(n).....important source of change during the nineteenth century was a gradual shift in the perceived identity of mathematics. Until perhaps the middle of the century such topics as celestial mechanics, hydrodynamics, elasticity, and the vibrations of continuous and discontinuous media were at the center of professional mathematical research. Seventy-five years later, they had become "applied mathematics", a concern separate from and usually of lower status than the more abstract questions of "pure mathematics" which had become central to the discipline.... [This separation] occurred in different ways and at different rates in different countries. (pages 60-61)

Historically, there has been considerable and, at times, heated discussion about the nature of mathematics and, inevitably, about the type of content most appropriate to school mathematics. An examination of some of the details of such discussions will help clarify certain aspects of the curriculum models to be presented later.

Pure Mathematics

Much has been written (Eves and Newsom, 1963; Benacerraf and Putnam, 1964; Nagel and Newman, 1968; Wilder, 1968; Barrett, 1979) about attempts around the turn of the century to secure the foundations of mathematics after the surge of research activity in the preceding two centuries. The details of Russell's logicism, Brouwer's intuitionism, and Hilbert's formalism need not be examined here, but some consideration must be given them if only because it has been argued elsewhere (Kline, 1977; Barrett, 1979) that the goals of logicism and formalism, in particular, have had an impact on both the orientation of research in mathematics and on the mathematics curriculum of the schools.

According to Russell (Moritz, 1958), "Pure mathematics is the class of all propositions of the form 'p implies q', where p and q are propositions containing one or more variables, the same in the two propositions, and neither p nor q contains any constants except logical constants." Russell goes on to say that "mathematics may be defined as the subject in which we never know what we are talking about, nor whether what we are saying is true." (page 7)

The formalist program of David Hilbert (a German of the Göttingen school as were Gauss, Riemann, Klein, and later Courant) has, even more than the logicist one, had an impact on the school mathematics curriculum. Hilbert himself was an eminent mathematician who worked in a number of different fields and with varying degrees of rigor. He is credited (Eves and Newsom, 1963), on the one hand, with having "sharpened the mathematical method from the material axiomatics of Euclid to the formal axiomatics of the present day," (page 142), and on the other hand, with having produced a classic intuitive exposition of geometry in Geometry and the Imagination with Cohn-Vossen.

The basis for Hilbert's formalist position was his desire to provide a consistent, finite, axiomatic foundation for all of classical analysis (Wang, 1978). In Hilbert's view "mathematical expressions are regarded simply as empty signs. The postulates and theorems constructed from the system of signs ... are simply sequences of meaningless marks which are combined in strict agreement with explicitly stated rules." (Nagel and Newman, 1968, page 224) Von Neumann (1964) described the formalist approach as follows:

> The leading idea of Hilbert's theory of proof is that, even if the statements of classical mathematics should turn out to be false as to content, nevertheless, classical mathematics involves an internally closed procedure which operates according to fixed rules known to all mathematicians and which consists basically in constructing successively certain combinations of primitive symbols which are considered "correct" or "proved". (page 50)

Hilbert's goal of establishing the absolute consistency of a deductive system was shown by Gödel, in 1931, to be unattainable for any system as complex as that of the arithmetic of natural numbers. In his Incompleteness Theorem, Gödel demonstrated that any "suitably strong" system will contain statements whose truth or falsity is undecidable within that system. (Hofstadter, 1979)

According to Barrett (1979), mathematics research in America has been dominated by the goals of formalism. Felix Browder and Saunders Mac Lane (1978), both eminent American mathematicians, draw a careful distinction between Hilbert's formalist program and the research paradigm which grew out of it.

> In its most vulgar form (and it is the vulgar forms of sophisticated intellectual doctrines that tend to sweep across the intellectual

> landscape), the formalist doctrine was taken to say that mathematics consists simply of the formal manipulation of uninterpreted symbols, or of reasoning by formal deduction (itself reduced simply to symbolic manipulation) from any assumptions whatever as long as they could be presented in an explicitly symbolic form. Taken in this form (and it is clear from his explicit statements that Hilbert would have found this form of the thesis horrifying), the vulgar formalist doctrine argued against even the possibility of any objective content for any part of mathematics. It even seemed to argue against the significance and the content of the historically conditioned mathematical fields, as well as against their intuitions and central problems. In the context of applying mathematics to the analysis of the phenomena of the natural world, it makes any significant application a miracle on principle and a triumph of will over content. (page 344)

Browder and Mac Lane then go on to argue that the effect of what they term vulgar formalism has been felt not only in the mathematical culture but even more so in some scientific fields which make use of mathematics. They contend that:

> While the vulgar formalist attitude towards mathematics has never achieved a totally dominant influence upon mathematical research even when unchallenged as an ideology, the very similar instrumentalist viewpoint of the contemporary theoretical physicist towards mathematics became dominant in physics. (page 345)

Although formalism and abstraction are certainly not equivalent terms, the abstract orientation of much of the mathematical research on this continent and elsewhere during this century has reinforced the formalist view of the nature of mathematics. As Marshall Stone (Griffiths and Howson, 1974) has noted:

> When we stop to compare the mathematics of today with mathematics as it was at the close of the nineteenth century, we may well be amazed to note how rapidly our mathematical knowledge has grown in quantity and complexity, but we should also not fail to observe how closely this development has been involved with an emphasis on abstraction and an increasing concern with the perception and

> analysis of broad mathematical patterns. Indeed, upon closer examination we see that this new orientation, made possible only by the divorce of mathematics from its applications, has been the true source of its tremendous growth during the present century. (page 120)

While not disagreeing with Stone as to the facts of the matter, the following quotation from The Thirty-Second Yearbook of the National Council of Teachers of Mathematics (NCTM) (Jones, 1970) presents a somewhat less-glowing picture:

> The tendency for American mathematical research to be very pure, and in the general area of the foundations of mathematics rather than in applied mathematics, continued into the twentieth century, becoming a real national handicap at the time of World War II. (page 30)

One of the clearest indications of the impact of abstract formalistic thinking on school mathematics in America may be found in the following remarks by the late E. G. Begle (1979), the mathematician-turned-educator who headed the extremely influential School Mathematics Study Group (SMSG) in the U. S. A. He said, "I consider mathematics to be a set of interrelated, abstract, symbolic systems." (page 1) Two pages later he stated that, "We are dealing with an abstract (the symbols, so far, are meaningless), symbolic (we have nothing but symbols and strings of symbols) system." (page 3) (emphasis in the original) Although Browder and Mac Lane (1978) feel that the influence of formalism on professional mathematical activity is in decline, they also maintain that "vulgar formalism has been spread on a much more explicit level and to a much wider public than it ever reached before through the formalist thrust of a large part of the new curricula in the elementary and secondary schools." (page 345)

Hersh (1979), a critic of formalism and of the goal of providing "secure" foundations for mathematics in general, states that there is a definite connection between this orientation and the reality of school mathematics, not only in terms of specific content but also in terms of presentation and motivation of the subject. He contends:

> The last half-century or so has seen the rise of formalism as the most frequently advocated point of view in mathematical philosophy. In this same period, the dominant style of exposition in mathematical journals, and even in texts and treatises, has been to insist on

> precise details of definitions and proofs, but to exclude or minimize discussion of why a problem is interesting, or why a particular method of proof is used.... One's conception of what mathematics *is* affects one's conception of how it *should be* presented.... Another example is the importation, during the '60's, of set-theoretic notation and axiomatics into the high-school curriculum. This was not an inexplicable aberration, as its critics sometimes seem to imagine. It was a predictable consequence of the philosophical doctrine that reduces all mathematics to axiomatic systems expressed in set-theoretic language. (page 33) (emphasis in the original)

Hersh goes on to conclude that:

> (1) The unspoken assumption in all foundationist viewpoints is that mathematics must be a source of indubitable truth.
> (2) The actual experience of all schools--and the actual daily experience of mathematicians--shows that mathematical truth, like other kinds of truth, is fallible and corrigible. (page 43)

Such views are similar to those formulated by Imre Lakatos, whose mentors were Karl Popper and George Polya. The recent focus on problem solving within the mathematics education community (NCTM, 1980) provides special impetus for critically considering Lakatos' stance concerning the nature of the discipline. In his book, Proofs and Refutations: The Logic of Mathematical Discovery, Lakatos (1976) asserts that:

> Formalism denies the status of mathematics to most of what has been commonly understood to be mathematics, and can say nothing about its growth. None of the "creative" periods and hardly any of the "critical" periods of mathematical theories would be admitted into the formalist heaven, where mathematical theories dwell like the seraphim, purged of all the impurities of earthly uncertainty. (page 2)

In Lakatos' opinion, "informal, quasi-empirical, mathematics does not grow through a monotonous increase of the number of indubitably established theorems but through the incessant improvement of guesses by speculation and criticism, by the logic of proofs and refutations." (page 5)

Applied Mathematics

In contrast to the formalist view of mathematics as pure is that held by those who see the subject as being closely linked to its applications. Interestingly enough, so-called applied mathematicians have frequently refused to adopt an either-or position on the pure versus applied distinction, preferring instead to promote a compromise between the two extremes. Thus, Richard Courant (1941) in the preface to his classic text, What is Mathematics?, says:

> "Mathematics as an expression of the human mind reflects the active will, the contemplative reason, and the desire for aesthetic perfection. Its basic elements are logic and intuition, analysis and construction, generality and individuality. Though different traditions may emphasize different aspects, it is only the interplay of these antithetic forces and the struggle for their synthesis that constitute the life, usefulness, and supreme value of mathematical science.
>
> "Without doubt, all mathematical development has its psychological roots in more or less practical requirements. But once started under the pressure of necessary applications, it inevitably gains momentum in itself and transcends the confines of immediate utility. This trend from applied to theoretical science appears in ancient history as well as in many contributions to modern mathematics by engineers and physicists....
>
> "However, while the theoretical and postulational tendency of Greek mathematics remains one of its important characteristics and has exercised an enormous influence, it cannot be emphasized too strongly that application and connection with physical reality played just as important a part in the mathematics of antiquity, and that a manner of presentation less rigid than Euclid's was very often preferred." (pages xv-xvi)

He cautions his readers about the danger of over-emphasizing the deductive character of mathematics.

> If the crystallized deductive form is the goal, intuition and construction are at least the driving forces. A serious threat to the

> very life of science is implied in the assertion that mathematics is nothing but a system of conclusions drawn from definitions and postulates that must be consistent but otherwise may be created by the free will of the mathematician. If this description were accurate, mathematics could not attract any intelligent person. It would be a game with definitions, rules, and syllogisms, without motive or goal. The notion that the intellect can create meaningful postulational systems at its whim is a deceptive half-truth. Only under the discipline of responsibility to the organic whole, only guided by intrinsic necessity, can the free mind achieve results of scientific value. (page xvii)

Similar opinions have been voiced in other countries such as the Soviet Union (Aleksandrov, Kolmogorov, Lavrent'ev, 1963) and the United Kingdom (Griffiths and Howson, 1974).

Henry Pollak (1979, page 233), in a paper discussing the interaction between mathematics and other school subjects, presents four definitions of applied mathematics.

(1) "Applied mathematics means classical applied mathematics," which includes the various branches of analysis as well as algebra, trigonometry, and geometry from the secondary school curriculum.
(2) "Applied mathematics means all mathematics that has significant practical application." This would include all of the topics in the current secondary school curriculum plus such topics as probability, statistics, linear algebra, and computer science.
(3) "Applied mathematics means beginning with a situation in some other field or in real life," constructing and working within a mathematical model of the situation, and then applying the results to the original situation.
(4) "Applied mathematics means what people who apply mathematics in their livelihood actually do." This definition is similar to the one given in (3).

He then goes on to discuss, in some detail, each of these definitions and to show the implications of each for the school curriculum.

Pollak's third and fourth definitions emphasize process rather than content. A key implication for school mathematics emanating from these two definitions is that the process of model building should be emphasized rather than the applications themselves. Howson (1978), for example, is quite critical of some of the material produced by the Sixth Form

Mathematics Project (an applied, upper-secondary level project) for merely putting narrow problems in an applied setting and avoiding the model building process. (page 207)

The term "mathematization" has been used to describe an approach to the teaching and learning of mathematics based upon the skills of model-building and John Trivett of Simon Fraser University and David Wheeler of Concordia are among the Canadian proponents of such an instructional approach. Beltzner, et al. (1976) quote Wheeler approvingly and then give the following admonition:

> The absorption and retention of "facts" should not be the main object of the teaching-learning process - but rather an important by-product. The main aim should be that of exploiting, and extending the ability to "mathematize" which is inherent in all thinking individuals - by encouraging the student to exult in the "algebraic" character of mental functioning. (page 119)

Mathematics as a Creative Art

Mathematicians, whether pure or applied, have often written and spoken about their field in terms one usually associates with the fine arts rather than the sciences. They see mathematics as a realm of endeavor characterized by insight, creativity, and beauty. One of the major arguments to be found in the literature concerning the reasons for studying mathematics is the inherent beauty of the subject, its structures, and its patterns.

G. H. Hardy (1967), the British mathematician, put it the following way:

> A mathematician, like a painter or a poet, is a maker of patterns. If his patterns are more permanent than theirs, it is because they are made with *ideas*....
> The mathematician's patterns, like the painter's or the poet's, must be *beautiful*; the ideas, like the colors or the words, must fit together in a harmonious way. Beauty is the first test: there is no permanent place in the world for ugly mathematics. (pages 84-85) (emphasis in the original)

Hardy's mathematics was pure mathematics and he took great delight in that fact. He said, "I have never done anything 'useful'. No discovery of mine has made or is likely to make, directly or indirectly, for good or ill, the least dif-

ference to the amenity of the world." (page 150) He did say, however, "I have added something to knowledge...which differs in degree only, and not in kind, from that of the creations of the great mathematicians, or of any of the other artists, great or small, who have left some kind of memorial behind them." (page 151)

The Hungarian-born American mathematician, Paul Halmos (1968), described his art in the following way:

> For the professional pure mathematician, mathematics is the logical dovetailing of a carefully selected sparse set of assumptions with their surprising conclusions via a conceptually elegant proof. Simplicity, intricacy, and above all, logical analysis are the hallmark of mathematics. (page 380)

and later:

> It is, I think, undeniable that a great part of mathematics was born, and lives in respect and admiration, for no other reason than that it is interesting--it is interesting in itself.... Don't all of us feel the irresistible pull of the puzzle? Is there really something wrong with saying that mathematics is a glorious creation of the human spirit and deserves to live even in the absence of any practical application? (page 386)

Finally, he says:

> I hope just the same, that I've shown you that there is a subject called mathematics... and that that subject is a creative art. It is a creative art because mathematicians create beautiful new concepts; it is a creative art because mathematicians live, act, and think like artists; and it is a creative art because mathematicians regard it so. (page 389)

Applied mathematicians have also spoken about this issue. Morris Kline (1962) is an applied mathematician whose greatest technical contributions to mathematics have been in the area of the mathematical behavior of radio waves. He has also been a harsh critic of what he perceives as being an extreme overemphasis on formalism and abstraction in mathematics research and teaching. He, like Courant, rejects the pure-applied distinction and, regarding the artistic side of mathematics, he observes:

> Mathematics offers artistic outlets not only in the creation of theorems and proofs, but in the expression of its material. A painter may have a great theme but he must also present it most effectively. The same is true in mathematics. The symbolism can be employed neatly and suggestively just as words are used in poetry. (page 671)

Later, he continues:

> Perhaps the best reason for regarding mathematics as an art is not so much that it affords an outlet for creative activity as that it provides spiritual values. It puts man in touch with the highest aspirations and loftiest goals. It offers intellectual delight and the exaltation of resolving the mysteries of the universe. (page 671)

Summary

The purpose of this section has been to examine several conceptions of the nature of mathematics, since it has been suggested (Otte, 1979) that the way in which mathematics is viewed by members of the mathematics community has a profound effect on the school curriculum as conceived and as realized. The categories discussed here were chosen more for the sake of convenience than out of any strong feeling for their superiority over some other categorization. Differing approaches to such a discussion of the nature of mathematics have been taken by Browder (1976) and Confrey (1980), to name only two. What seems clear is that some sort of analysis and discussion of the nature of mathematics is a prerequisite to the process of curriculum development.

The current literature in mathematics education contains increasingly frequent references to the ideas of Imre Lakatos, whose work was mentioned earlier. For example, Bill Higginson (1980) of Queen's University contends that "answers to some critical problems of long standing in mathematics education can be found in aspects of the theories of Karl Popper, Imre Lakatos and Jean Piaget." (page 6) Some possible implications of Lakatosian ideas for school mathematics have been suggested by Hersh (1979). He contends:

> The criticism of formalism in the high schools has been primarily on pedagogic grounds: "This is the wrong thing to teach, or the wrong way to teach." But all such arguments are inconclusive if they leave unquestioned the dogma that real mathematics <u>is</u> precisely formal

> derivations from formally stated axioms. If this philosophical dogma goes unchallenged, the critic of formalism in the schools appears to be advocating a compromise in quality: he is a sort of pedagogic opportunist, who wants to offer the student less than the "real thing". The issue, then, is not, What is the best way to teach? but, What is mathematics really all about? To discredit formalism in pedagogy, one must challenge its philosophical base: the formalist picture of the nature of mathematics. Controversies about high-school teaching cannot be resolved without confronting problems about the nature of mathematics. (page 33-34) (emphasis in the original)

Whether Hersh has over-stated the case or whether, as Agassi (1980) has suggested, a Lakatosian revolution is imminent, is far from clear. What is clear is that the prevalent perceptions of the nature of mathematics are an important determinant of the school mathematics curriculum.

2.2 Factors Influencing the Curriculum Development Process

Earlier, the curriculum development process was portrayed as a mediator between the domain of mathematics and that of school mathematics. The function of the curriculum development process is to restructure mathematics into a form appropriate for the school curriculum. This restructuring process is influenced by a number of factors, each of which affects the development of the mathematics curriculum in a specific way. Four such factors will be discussed here.

Sociological Factors

Both the content and the methodology of school mathematics are influenced by sociological factors beyond the control of the school and by the nature of the school setting itself. As Bauersfeld (1980) has observed:

> Teaching and learning mathematics is realized in <u>institutions</u> which the society has set up explicitly to produce shared meanings among their members. Institutions are represented and reproduced through their members and that is why they have characteristic impacts on human interactions inside of the institutional.[sic] They constitute norms and roles; they develop rituals in actions and in meanings; they tend to seclusion and self-suf-

ficiency; and they even produce their own content--in this case, school mathematics. (pages 35-36) (emphasis in the original)

The past twenty years or so have provided a number of examples of the influence of sociological factors on the mathematics curriculum of the schools. During the New Math era, for example, mathematics was considered by many as requiring increased attention and prominence in the schools. In the United States, all of the physical sciences as well as mathematics benefitted from an enormous influx of government and private foundation funds during the late 1950s and the 1960s, in part as a result of the successful launching of the first unmanned earth satellite by the Soviet Union in 1957.

The picture in the United States regarding public support for mathematics and the physical sciences has changed dramatically in the last two decades. As the report of the National Advisory Committee on Mathematical Education (1975) makes clear, the importance of mathematics and the sciences has declined in public opinion, and students' interests are being directed elsewhere. As a result, financial support for curriculum development and research in mathematics is not nearly as strong as it was.

More recently we have witnessed, on the one hand, the rise of "accountability" in the schools as a response to public pressure about the high costs of schooling; and, on the other hand, we have seen disquiet about claims that standards are falling. The so-called back-to-basics movement,[4] minimum competency testing, and the growth of provincial, state, and national assessment programs may all be viewed as responses by school systems to demands from the society which they serve.

Teachers are members of the society in whose schools they teach, and therefore are in a somewhat ambiguous position regarding innovations in teaching practice and materials. In House's (1979) opinion, many curricular innovations have failed because they were subverted by teachers and never implemented. The innovators frequently failed to account for the critical role of classroom teachers and neglected to involve them in the development process. For example, there is mounting evidence (Brandt and others, 1979; Fey, 1979; Robitaille, 1981) that the New Math was never fully implemented in schools,[3] and that teachers have not responded as positively or as enthusiastically as might have been expected to the

[4]This movement is a world-wide phenomenon. According to Kolyagin, Lukankin, and Oganesyan (1980, page 74) in the Soviet Union it is known as the "return to Kiselev" movement.

adoption of the metric system or to the use of calculators and computers in schools (Robitaille and Sherrill, 1977).

It has also been argued that innovations which stressed an inquiry approach or learning by discovery frequently had little impact because of their lack of fit with a rule-obedience function of school mathematics. Easley (1979), for example, contends that:

> Some teachers might even admit to using arithmetic as a kind of moral training in the sense that students can be taught to be neat and orderly, to be responsible for doing their work on time and getting it turned in in proper form, and being responsible for their own work and not getting help from other people. These are really moral values for which arithmetic is seen by many teachers to be a suitable instrument, not the only instrument but one very suitable instrument. (page 9) (emphasis in the original)

Although it has not been done here, it would certainly be possible to discuss the impact of sociological factors on the curriculum development process in a broader context. It may be, for example, that the type of social and political system operating in a given place at a given time influences not only the educational system in general but, in particular, the mathematics curriculum. As Howson (1980) has observed:

> It is usual in mathematical periodicals--even those devoted to education--to fight shy of political issues. For example, curricula and school organisational patterns are presented and discussed in an aseptic, non-political manner. Yet mathematics education in any country cannot be divorced from politics, and we delude ourselves if we believe that this is not so. (page 285)

Howson continues with a critique of Swetz's (1978) formulation and analysis of the phenomenon of "socialist mathematics education". Such cross-political comparisons are beyond the scope of the present paper and, as can be inferred

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[5]Beltzner et al. (1976) consider the New Math movement in Canada to have failed because, in their opinion, only the appearance of New Math was incorporated in most textbooks and those textbooks "attempt to teach jargon rather than ideas." (page 122)

from Howson's paper, much careful analysis remains to be done before any meaningful conclusions can be drawn in this area. Nonetheless, it seems clear that any program of curriculum revision which seeks to incorporate aspects of an apparently successful innovation from a different jurisdiction must include an analysis of the social and political differences between the two places.[6]

Psychological Factors

Griffiths and Howson (1974) have stated that in Great Britain psychological theories have not had a very great impact on the mathematics curriculum, especially at the secondary school level. They do say, however, that among the exceptions to this general rule are the materials produced by the Nuffield Project, the work of Her Majesty's Inspector Edith Biggs, and, to a lesser extent, that of Richard Skemp.

In North America, on the other hand, the mathematics curriculum and the teaching of mathematics have both been fairly heavily influenced by changing beliefs and theories about the ways in which children learn and what they are capable of learning at various age levels. Although some such beliefs and theories have been short-lived, a few have demonstrated remarkable durability and resistance to change.

A great many educators still subscribe to a form of the theories of mental discipline and transfer of training as they apply to mathematics. They believe that subjects like mathematics help teach students to "think logically" both in mathematical and non-mathematical situations. In a study conducted among teachers of secondary school mathematics in British Columbia (Robitaille, 1973), for example, it was found that when teachers were asked to rank some twenty objectives for the teaching of geometry, the five objectives which were ranked highest had nothing to do with geometry itself, or with mathematics for that matter. All of them were either mental discipline or transfer objectives. The belief, however ill-founded, that the study of Euclidean synthetic geometry will assist in the development of students' ability to think logically, has persisted in spite of results such as those reported by Fawcett (1938) and, more recently, Williams (1980).

[6]MacDonald (1977), for example, has compared the relative influence of American and British approaches to the New Math on the Australian curriculum. In his opinion, "The upshot was that the transition to new mathematics programs in many parts of this country combined some of the worst features of both the U. K. and the U. S. experiences!" (page 56)

Behaviorist theories of learning, from those of E. L. Thorndike to Robert Gagné, have also had a considerable and lasting influence on the teaching of mathematics. Thorndike's laws of exercise, effect, and readiness were based upon his rejection of a logical, axiomatic presentation of arithmetic. Critics of his connectionist psychology have asserted that he rejected meaning in mathematics along with axiomatics (Jones, 1970). Thorndike himself (1921) admonished his readers that:

> Arithmetic makes a very strong appeal to two potent interests--the interest in mental activity and the interest in achievement. Many children like arithmetic in the same way and for much the same reasons that they like puzzles, riddles, checkers, chess, and other intellectual games. Almost all children like to have their tasks definite so that they can know what they have to do and when it is done, and enjoy the sense of action, achievement, and mastery. (page 14)

He encouraged teachers to "use arithmetical games, races, matches, and the like ... when such games, races, and the like are just as instructive as mere drill for drill's sake." (page 28) While it is clear that Thorndike's formulation of bonding lost credibility in the 1930s, it must be recognized that many teacher- or commercially-produced games and puzzle worksheets are based upon a Thorndikean view of learning.[7] Smith (1976), in discussing the impact of Thorndike's work, says that "by and large [Thorndike's] conception of how learning occurs has permeated our thinking about teaching to such an extent that we are often unaware that we are persuaded by his views." (page 25)

More recently, the construction of so-called task analyses and behavioral objectives has enjoyed wide popularity in North America. The Dutch mathematician, Hans Freudenthal (1978a), decries this "atomisation", to use his terminology, in the strongest terms. He points out that this practice has not taken such a firm hold in other countries, pointing in particular to the Nuffield project materials in Great Britain as well as to work by Tamas Varga in Hungary and Emma Castelnuovo in Italy.

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[7] Just as Browder and Mac Lane (1978) distinguished between Hilbert's view of formalism and its "vulgar" derivative, one might also distinguish between Thorndike's actual formulations and their vulgar derivatives.

During the New Math era the work of Jerome Bruner (1963) was extremely influential in the educational literature, if not in the typical classroom. His declarations to the effect that "any subject can be taught effectively in some intellectually honest form to any child at any stage of development," (page 33) and that the best way to learn mathematics[a] is by behaving like a mathematician, were hallmarks of that period. At the primary school level, the developmental theory of Jean Piaget continues to exert an important influence on the teaching of mathematics in North America and elsewhere.

Piaget's (1973) conclusion that "there exists, as a function of the development of intelligence as a whole, a spontaneous and gradual construction of elementary logico-mathematical structures and that these 'natural' ... structures are much closer to those being used in 'modern' mathematics than to those being used in traditional mathematics" (page 79) has sometimes been used, along with Bruner's declaration, to justify the inclusion of modern mathematics in final, finished form in the school curriculum. However, Piaget himself states:

> With modern mathematics... the teacher is often tempted to present far too early notions and operations in a framework that is already very formal. In this case the procedure that would seem indispensable would be to take as the starting point the qualitative concrete levels: in other words, the representations or models used should correspond to the natural logic of the levels of the pupils in question, and formalisation should be kept for a later moment. (pages 86-87)

It should be noted in this connection that the Harvard Mathematics Project conducted by Bruner and Dienes (Dienes, 1963) relied heavily on the use of concrete apparatus although one of their objectives certainly was to accelerate the process of formalization.

Reactions to these theories and beliefs has varied both between and within countries. For example, Jim Fey (1978) of the University of Maryland criticized many of the American New Math programs for the elementary school as having been "conceived in a naive optimism that young children could achieve far more than had ever been expected of them." (page 341) On the other hand, Max Bell (1980) of the University of

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[a]Bruner's comment was actually made about physics, not mathematics.

Chicago, in an address to the annual meeting of the NCTM, said that one of the major problems facing mathematics educators in the 1980s was a "pervasive pessimism about young children's mathematics abilities." (page 17-1)

Although a great deal of research has been done on the topic of how children learn mathematics, "progress has been slow and our knowledge of mathematical learning processes meagre." (Chapman, 1972, page 153) Many of the most fundamental questions remain only partially answered, and the list of issues or questions which have been answered definitively is all too short.

Pedagogical Factors

The methods and materials used by teachers of mathematics are important determinants of the mathematics curriculum as it is attained by students. So too are the qualifications, both academic and professional, of the teachers themselves.

At the elementary school level in many countries, teachers have little or no academic preparation in mathematics beyond the secondary school level (OEEC, 1961). In British Columbia, for example, approximately twenty-five percent of the elementary school teachers surveyed in 1977 (Robitaille and Sherrill, 1977) indicated that they had no post-secondary training in mathematics.

Elementary teachers tend to be generalists while their secondary school counterparts are more likely to be subject matter specialists. The resulting dichotomy between "child-orientation versus subject matter-orientation" has, in Otte's terms (1979, page 126), been a source of antagonism in discussions of the pedagogy of mathematics. The pros and cons of permitting only specialists to teach mathematics have been debated for many years, but no resolution of this argument appears imminent.

The type of training which universities provide for prospective teachers of mathematics is also an important issue. Reporting on the PRIME-80 conference which was sponsored by the Mathematical Association of America and which was intended to identify directions for the university-level training of future mathematicians and teachers of mathematics, Steen (1978b) states rather ominously that:

> Moreover, 60% of undergraduate mathematics enrollments are now in applied areas, with the remaining 40% split evenly between required and elective courses. Only those students preparing for careers as high school teachers are continuing to take the traditional courses -

> because they are required to by certification regulations. This situation ... is doubly dangerous: not only does it mean that future high school teachers may be ill-prepared to cope with their students' demands for new applications, but the commitment to teaching disqualifies them from other mathematics-related jobs that now universally require majors with an applied concentration. (page 172)

The subject matter content of the curriculum and the nature of the population of students at a given grade level who are studying mathematics vary considerably from place to place, particularly at the secondary school level. Thus, in some European countries, a substantial portion of the last year of secondary school mathematics is devoted to the study of calculus. In such countries, it is often the case that only a small proportion of the student population is permitted to continue their studies of mathematics beyond the minimum compulsory level. In other words, these countries have formal "streaming" or "tracking" programs[9] whereby students who have been identified as highly capable in a given subject area are challenged to explore those areas in some depth.

In both Canada and the United States, a larger proportion of students studies mathematics beyond the compulsory level than in many other countries. In most school jurisdictions in North America, however, there is some sort of provision made for talented students to specialize or to complete the regular courses in an accelerated way and then follow a program such as Advanced Placement through which high school students can gain up to one-year's university credit in calculus. In British Columbia, although a few elective courses have been included in the secondary school mathematics curriculum, no program of acceleration or specialization is defined in the Curriculum Guide. As a matter of fact, the so-called honors course at the Grade 12 level was discontinued several years ago.

A pedagogical situation which appears to be unique to British Columbia is that of semestering or, in some cases, quartering of mathematics courses. In some schools, for example, students take a course such as Mathematics 8 during the first semester (September to January), and then take no mathe-

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[9]According to two papers recently published by Unesco (Hayter, 1980; Kawaguchi, 1980), for example, qualified students in the United Kingdom and Japan may spend between 10 and 18 hours a week taking mathematics courses at the senior secondary level.

matics course during the second semester. In other parts of Canada and in the United States, this type of semestering of courses may be relatively common at the Grade 12 level, but is rarely seen at lower grade levels.

Technological Factors

In British Columbia, the influence of technological factors on the mathematics curriculum and the teaching of mathematics has been minimal. Results from a survey of mathematics teaching practices in British Columbia (Robitaille and Sherrill, 1977) indicate that little use is made of audio-visual aids and equipment other than the overhead projector. Moreover, only a small percentage of teachers who have access to computers actually make use of them in their teaching of mathematics either for instructional or managerial functions. The use of calculators is favored by teachers for secondary school students, but not for elementary school students and not during examinations.

Other countries appear to make more extensive use of various media, for example, in the production of radio and television programs in mathematics for the schools. Heimer (1979) states that, at a conference held in 1967, reports of radio and television programs in mathematics were received from Denmark, Australia, France, Hungary, Ireland, and the United States. He also states that since 1957, the BBC has produced more than 300 such programs, and that the Federal Republic of Germany, Brazil, Japan, the United States, and Hong Kong have "recently mounted important television or radiovision projects in mathematics." (page 222) Of course, without further information, one must be careful not to equate the existence of particular programs or innovations with their widespread use and implementation.

Of all the various technological devices and materials, the calculator seems certain to have the greatest impact on the schools and on the teaching of mathematics. In some countries their use is virtually universal and students use them at all times, even during examinations. In other countries calculators are rarely found in schools and their impact has yet to be felt.

The situation in British Columbia regarding calculators is somewhere between these two extremes, and some decision regarding their place and availability in the schools will have to be made in the near future. The question of whether it makes sense, economically or educationally, to devote so much time to the development of children's ability to compute when low-priced, powerful calculators are readily available must be addressed. Wheatley (1980), for example, has proposed the following changes to the mathematics curriculum of the elementary

school:

- shift from a computationally based curriculum to a conceptually oriented curriculum using the calculator as an instrumental tool, and
- eliminate the teaching of complex computations in the elementary school. (page 37)

Wheatley's second recommendation is the more straightforward of the two. Suggestions to eliminate such computational skills as long division with divisors of more than two digits, and multiplication by multipliers having more than two digits are clear and unambiguous. His first point is more problematic, both in terms of its meaning for curriculum developers and of the form in which such a curriculum would in fact be implemented by teachers. As Roberts (1980) has stated in reviewing the results of research into the use of calculators:

> Although the proposition that calculator usage can have an impact on mathematical concept formation seems reasonable, it is not supported thus far by the empirical data available. In fact, a strong case can be made that this hypothesis has not been adequately tested since few studies made any real attempt to carefully integrate calculator use into the curriculum that would illustrate how calculators can facilitate concept learning. (page 84)

While the phrase, "conceptually oriented curriculum", is open to many, perhaps rather contradictory, interpretations, any forecast of curricular change in this direction arising from the introduction of calculators into the classroom must be tempered by data such as that reported by teachers in the 1977 British Columbia Mathematics Assessment (Robitaille and Sherrill, 1977). When asked where the major emphasis should be placed in the mathematics curriculum, less than seven percent of the elementary school teachers polled favored a greater emphasis on the development of concepts and principles than on computational skills and drill. (page 43)

Given the pre-eminent position of computational skills in the curriculum, at least in North America, on the one hand, and the power and availability of calculators on the other, it would appear that some sort of large-scale curricular impact is inevitable. The fate of previous innovations, as well as the influence of other factors within the curriculum development process, however, makes it virtually impossible to predict the precise nature of any such change with any high degree of confidence. For those undertaking curriculum revi-

sion, an in-depth analysis of the specific uses and implications afforded by this device would seem to warrant top priority.

The ever-increasing availability of micro-computers also has important implications for both the content of the school mathematics curriculum as well as the emphasis to be placed on different topics. Ultimately, the presence of such devices in classrooms will have implications for teaching methodology as well.

Summary

The curriculum development process in mathematics is influenced or affected by a number of factors, four of which have been discussed here: sociological, psychological, pedagogical, and technological. In every place where mathematics is taught, different weight is attached to and different concerns dominate each of these factors. This has the ultimate effect of producing different curricula, each of which is unique to the particular place for which it was developed.

2.3 Models for the Mathematics Curriculum

Earlier, in Figure 2-1, the school mathematics curriculum was portrayed as being an outgrowth of the nature of the subject itself, adapted, filtered, and restructured by the curriculum development process. Four factors which influence that process were described and their role in the emergence of a particular model for the mathematics curriculum is portrayed in Figure 2-2.

One might conceive of several different curriculum models for mathematics, each one based on a particular view of the nature of the subject and conditioned by sociological, psychological, pedagogical, and technological factors. Of this number, there are three which are prevalent today: a model which emphasizes mathematics as the science of abstract structures and their properties, a second which stresses the applications of mathematics to other disciplines, and a third which emphasizes the importance of mathematics in everyday living. These models will be referred to, respectively, as the Pure Mathematics model, the Applied Mathematics model, and the Basic Mathematics model.

The Pure and Applied Mathematics models are more or less directly derived from the corresponding views of the nature of the discipline. Such views are then filtered through the curriculum development process, and influenced by factors such as the sociological, psychological, pedagogical, and technolo-

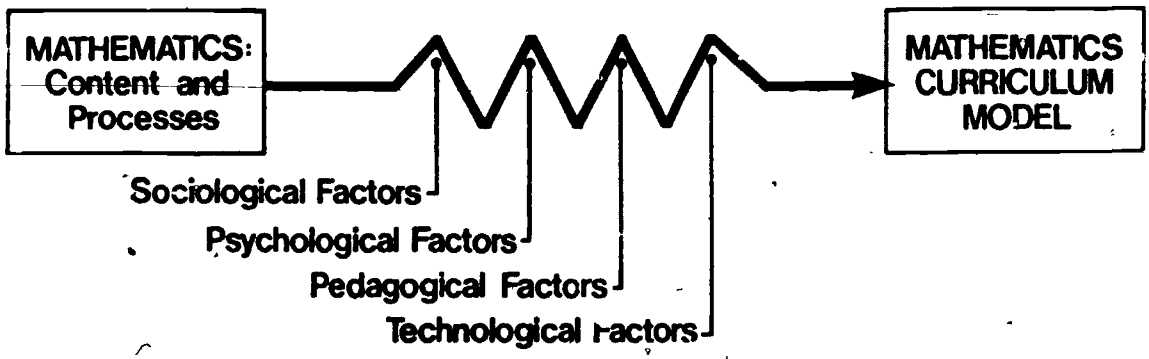

Figure 2-2. Development of a mathematics curriculum model.

gical ones discussed earlier. In contrast, the third model has only a tenuous connection with any view a mathematician might have of the nature or the value of the subject. Although Poincaré's admission that he inevitably made errors in carrying out column addition exercises may not be characteristic of professional mathematicians in general, there is no reason to believe that computational ability or a good memory for formulas, for example, are necessary components of creative ability in mathematics (Krutetskii, 1976). The Basic Mathematics model is much more a direct product of the influence of factors such as the sociological and pedagogical than a derivative of a particular view of the nature of mathematics.

In practice, these three models are seldom if ever found in a pure state. Thus, the mathematics curriculum for a given place and for a given grade level might advocate placing greater emphasis on one model than on either of the others, but it is extremely unlikely that a curriculum would be constructed on the basis of one of these models to the total exclusion of the other two. For example, a particular curriculum might assign a pre-eminent role to the Pure Mathematics model and yet still include aspects of the Applied Mathematics and Basic Mathematics models. Similarly, it is difficult to imagine an entire mathematics curriculum being built solely around the Basic Mathematics model.

To illustrate how these models are applied in practice, three curricula will be considered: the French, the British, and the North American. The French and British examples illustrate the existence of conflicting views of the importance of the Pure Mathematics model as opposed to the Applied

Mathematics one. The North American example is important to this discussion not only because it is the context within which we are operating, but also because it appears to be in a somewhat fluid state at the present time as a result of a number of pressures for change that are being exerted both from within and outside the profession.

Due to limitations of space, the discussion of these curricula must be rather brief. Many details have had to be omitted and the resultant portrayal is somewhat over-simplified. In each of the three cases to be considered, the mathematics curriculum and the issues surrounding it are significantly more complex and less easy to categorize than might be inferred on the basis of the information presented here.

The French Curriculum

French society is more class-structured than North American society and the French educational system, by its selectivity, remains, despite attempts to democratize it, one of the major agencies which propagate that structure (Revuz, 1979). Revuz has also pointed out that mathematics is the major instrument for sorting students into different educational tracks, and he warns that continuation of this practice can do nothing but harm to the future of mathematics in France. He says, for example, "Success in mathematics has become the quasi-unique criterion for the career choices and the selection of pupils." (page 247) And later, "The use of mathematics as a selection instrument within the school system could spell death to mathematical education in France." (page 250)

France has had a long history of excellence in mathematics, but the direction of French mathematics research has changed dramatically in the last hundred years. As Kuhn (1977) points out, French mathematicians such as Laplace, Fourier, and Poisson mathematized physics during the first quarter of the nineteenth century but, for reasons which are unclear, after mid-century the attention of French mathematicians was diverted from the concrete concerns of physics toward the foundations of mathematics, culminating in the voluminous work of Nicolas Bourbaki.[10]

This fundamental re-orientation of mathematical focus has

had an impact on the school curriculum. The French mathematician, René Thom, speaking at the second International Congress on Mathematical Education in 1972 said, "In fact, whether one wishes it or not, all mathematical pedagogy, even if scarcely coherent, rests on a philosophy of mathematics. The modernist tendency is grounded essentially in the formalist conception of mathematics." (Otte, 1979, page 123)

An indication of the direction taken by reform in mathematics education in France may be found in the paper presented by the French mathematician, Jean Dieudonné, at the Royaumont Seminar in 1959 (OEEC, 1961).[11] At that conference, Dieudonné encouraged delegates to consider a number of fundamental reforms to the school mathematics curriculum. He encouraged the adoption of more precise terminology and language, and the replacement of traditional Euclidean geometry by linear algebra and, particularly, vector spaces. He also urged the adoption of a more rigorous, axiomatic development of school mathematics based upon "constant appeal to intuition" (page 39) (emphasis in the original) and "experimental work", particularly with younger children. In a later paper reviewed by Stevens and Garfunkel (1975), Dieudonné is quoted as saying that, for most teachers, "the only way they can arrive at a reasonably good understanding of mathematics and pass it on to their students will be through a careful presentation of their material, in which definitions, hypotheses, and arguments are precise enough to avoid any misunderstanding." (page 685) In the same vein, André Magnier, Honorary General Inspector of Public Education (France), said "the axiomatic presentation has become--since Hilbert--the key presentation method in mathematics." (page 10)

Many of Dieudonné's recommendations have become hallmarks of what North Americans understand to be the French mathematics curriculum. Similar programs emphasizing mathematics as the study of structures have been developed in Belgium and, for many North Americans, the texts and materials produced in Belgium by Georges Papy served as an introduction to the new

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[10]Bourbaki is the pseudonym adopted by a group of mathematicians, mainly French, who produced their first volume in 1939 and their thirty-first in 1965. André Weil and Jean Dieudonné have been among the leaders of the group. The origin of the name itself is obscure, perhaps borrowed from the Franco-Prussian War general, Charles Denis Sauter Bourbaki. (Boyer, 1968)

[11]In the proceedings of that conference, one finds Dieudonné's now-famous remark: "Euclid must go!"

approaches being tried in France and other francophone jurisdictions. In the United States, the Comprehensive School Mathematics Program directed by Burt Kaufman has drawn heavily upon Papy's work.

The elementary school mathematics curriculum in Belgium was described recently in a paper by De Bruyn (1980). He lists as major themes of the program, the following five topics: Sets and Relations, Numbers, Geometry, Measurement, and Applied Mathematics. The detailed listing of the content of the program is not broken down by age or grade level, but it is understood that "the ordering is not chronological, but the themes should evolve in symbiosis and the mathematical structures build up themselves progressively in filigree of the five themes." (page 19)

The Sets and Relations theme or strand contains topics such as the properties of equivalence relations, Venn diagrams, quantifiers, logical connectives, and Cartesian products. The Numbers strand includes the concept of infinite sets. integers, rational numbers. properties of operations, and arithmetic. The Geometry strand includes the study of plane and solid figures and their properties as well as the study of projections, symmetries, rotations, and translations. In the Measurement strand are topics such as length, area, volume, mass, time, and temperature. Applied mathematics accounts for approximately twenty percent of the curriculum and consists of topics such as equations, statistics, and probability.

In the same volume, a paper by Laumen, Bex, and Nachtergaele (1980) describes the content of the secondary school mathematics curriculum in the following terms:

> "The programs recommend the study of the main ideas concerning sets, relations, and functions; then the study of sets of numbers as structures; in geometry, the study of different sets of transformations and of their basic structure and that of vector spaces of 2 and 3 dimensions.
>
> "The teaching of analysis includes elementary concepts of topology.... Moreover, we hope to reach a unified teaching of mathematics, where the boundaries between algebra, geometry, trigonometry, etc. have been explicitly abolished.
>
> "Because of the introduction of modern concepts and the elimination of topics such as spherical trigonometry, descriptive geometry,

> and certain areas of arithmetic, we have been able to include in the secondary school curriculum an introductory treatment not only of algebraic structures, but also of integral calculus, statistics, and probability (page 28) (translated from the French).

The Pure Mathematics model has also had an impact on the mathematics curriculum in the Province of Quebec, as well as in other parts of Canada. In his work at the Université de Sherbrooke, for example, Zoltan Dienes[12] developed materials which emphasized mathematical structures. Moreover, the goals ranked first and second in the list of four basic aims of the elementary mathematics program for francophone schools in Quebec are:

> a. The exploration or acquisition of mathematical concepts, properties, relations, patterns, or structures.
>
> b. A growing familiarity with certain elements (verbal, graphic, or symbolic) of mathematical language necessary or useful for communication (McNicol, 1980, page 11) (translated from the French).

Computational skills are ranked third in this list, whereas they are ranked higher in each of the other provinces (McNicol, 1980).

It would be erroneous to assume that, even in France, the Pure Mathematics model has been universally adopted and accepted. Revuz (1979) reveals the existence of a considerable credibility gap regarding the new mathematics programs by saying:

> And there persists among the general public, and within government circles, the idea of an opposition between classical mathematics, austere but useful, of which it is necessary to acquire a "core" at all costs, and modern mathematics, clever and entertaining but in the last resort pointless, which one would put on the list of subjects of "enlightenment"--which might be a tribute to its value as mental training, or a polite way of saying that it is of secondary importance, to be sac-

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[12] Dienes' materials have also been used to some extent in France and elsewhere. (Bell, 1975)

> rificed when there is a cut in the timetable. (pages 243-244)

There are also indications, from certain spokesmen for the teachers, of dissatisfaction with current programs and practices in the teaching of mathematics. The October 1976 issue of the Bulletin Inter-IREM is devoted to a discussion of this topic under the title "Social Functions of the Teaching of Mathematics".

The British Curriculum

The traditional British school organization and curriculum have had a tremendous influence on school systems throughout the English-speaking world. In the realm of mathematics, for example, Howson (1979) describes the algebra text written by Hall and Knight as one "on which it could be claimed 'the sun never set'--for it was to be used for decades throughout the British Empire."[13] (page 156) This influence has abated somewhat, but is still very strong in such diverse places as India, Hong Kong, and the West Indies.

The British School system, in contrast to the French, is highly decentralized and "curriculum decisions are normally made at the school level." (Hayter, 1980, page 88) A major constraint on the freedom of the schools to initiate change would appear to be the external examinations which are prepared for secondary school students. Hayter says that "it is an anomalous feature of curriculum planning that, while the system would seem to enable innovation at a local level and provide the possibility of a mass movement within the system, it more normally appears as a damping medium for the implementation of innovation." (page 88) In particular, he mentions the effect of pressures to resist innovation as including parental and student expectations, teacher expertise, and the existence of external examinations.

The dominant British view of mathematics has always emphasized applied mathematics, and applied mathematics has historically been prominent both in the British mathematics curriculum and in mathematics research. Griffiths and Howson (1974) tell us that "throughout Britain 'Mathematics' in the twentieth century has always included 'Applied Mathematics', and it has always been the aim of schools to stress the applications of the subject." (page 141)

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[13] Their trigonometry text, first published in 1893, was still being used in anglophone schools in Quebec in 1965.

An examination of the material produced by the Nuffield Project and the School Mathematics Project (SMP) will confirm what Griffiths and Howson have said in comparing New Math in Great Britain to that in the U. S. The reason that the first U. S. curriculum project, headed by the late Max Beberman at the University of Illinois, was considered to be of little relevance to Britain might be that " 'modern' mathematics does not consist entirely of abstract algebra in England." (page 141) They also say that, consistent with this British view of mathematics, "great attention was paid to modern industrial applications of mathematics" from the beginnings of curricular projects in the late 1950s. They contrast this with what they view as an almost total absence of any applied orientation in the SMSG materials from the United States or in Papy's Belgian project.

Bryan Thwaites (1972), the director of SMP, says:

> It is a general belief in this country that mathematical concepts should be revealed gradually, being introduced at an intuitive level and developed in parallel with other intuitive ideas, so that patterns and logical frameworks slowly emerge....This view of the layout of a school mathematical course is in interesting contrast to, for example, the typical modern American view, in which early formality is thought to be concomitant with understanding, but it is one which has been propounded over many years in this country by such bodies as our Mathematical Association.... Intrinsic in the preceding points, and of fundamental importance to the way in which children learn, is the need at all levels for <u>multitudes of applications of the basic mathematical concepts</u>. (page 241-242) (emphasis added)

At the Fourth International Congress on Mathematical Education (ICME-IV) which was held at the University of California at Berkeley in August 1980, a leaflet entitled <u>SMP News</u> offered the following description of the approach taken in the materials produced by that project:

> The "modern" content, with new topics such as matrices, statistics, and vectors displacing some of the conventional algebra and euclidean geometry, was the most striking feature of the first SMP text-books. However, SMP materials embody an approach to mathematics teaching in which:
>
> • a topic is introduced through a situation

or application and the mathematics is developed from that situation;

- a mathematical idea is developed gradually, and the course returns to it in a helical fashion, to extend and deepen understanding;
- explanations and justifications are given for techniques and methods, which are always set in context;
- arbitrary rules are avoided;
- the text is written to be complete in itself, with the intention that the pupil can read it and thus take an active part in his learning.

The fairly obvious and understandable advocacy stance of the above remark must be borne in mind. Only through careful examination and observation of classrooms could the validity of these claims be substantiated. Nonetheless, examination of the contents of the SMP textbooks may offer a useful basis for making comparisons with North American materials.

SMP Books A - H are designed for use with students of average ability (the middle 50% of the population) in the 11-16 year age range. Book D could then be reasonably compared to materials prepared for use in Grade 8 in British Columbia. The Table of Contents of Book D contains the following chapter titles: Group Tables, Rotational Symmetry in 3-D, Order and Punctuation, Similarity and Enlargement, Multiplication and Division of Fractions, Vectors, Multiplication and Division of Directed Numbers, Looking for an Answer, Experimental Probability, Interpretation of Graphs, Number Patterns - Pascal and Fibonacci, Ratio and Percentage, Pythagoras.

Books 1 - 5 are designed for use by students between the ages of 11 and 16 who are in the upper quartile of the ability range. Accordingly, Book 3 might be considered more or less equivalent to the texts approved for use in British Columbia at the Grade 8 level. The contents of Book 3 are as follows: Probability, Isometries, Matrices, Rates of Change, The Circle, Networks, Three-Dimensional Geometry, Linear Programming, Waves, Functions and Equations, Identity and Inverse, Shearing, Statistics, Computers and Programming, Loci and Envelopes.

Another distinctive feature of the British mathematics curriculum has been the extent of teacher involvement in the development of new curricular materials. Howson (1979) says:

> One of the most successful of all projects--judged, <u>faute de mieux</u>, by degree of acceptance and longevity--is the School Mathematics

> Project of England. This is noteworthy for the fact that not only have all its writing groups consisted almost entirely of practising teachers, but it has consistently used part-time rather than full-time writers. Authors have written in their free time or have been given relief from some of their teaching duties to study and write. As a result, they have retained day-to-day contact with the classroom and have been able to try out their ideas there before committing them to paper. (page 144) (emphasis in the original)

The North American Curriculum

Although the title of this section includes the term "North American", the model which undergirds the curriculum originated in United States. In the past twenty years, Canadian provinces, with the possible exception of Ontario, have all adopted mathematics textbooks which were either produced in the United States or were produced originally in the U. S. and then "Canadianized".[14] There would not appear to be a distinctively Canadian model for the school mathematics curriculum.

Until very recently, it was clear that the dominant view of the nature of mathematics held by mathematicians in the United States was, as in the case of France, one which promoted pure mathematics. Barrett (1979) reports that American mathematics research was dominated by the goals of formalism, and reveals his own biases by saying that "a whole generation of mathematicians labored to abolish their subject by turning it over to the mechanism of a.ioms."(page 103) Begle (1974) had the following to say about the rise of the formalist school and its eventual application to the school mathematics curriculum:

> "Most mathematics educators extol structure for sound historical reasons. During the early part of the eighteenth century it became clear that further progress in mathematics itself would require that the basic concepts be rethought, clarified, and made more precise. It also became clear that in certain aspects of math.. tics, clever and intricate

[14]This means that the texts have been changed so that they use only metric units of measurement and that minor changes have been made in order to make the content more appropriate to Canadian students.

computations were less effective than a careful study of the structure of the mathematical system, the way in which the basic ideas fit together.

"This new point of view toward mathematics led to a tremendous flowering of mathematical activity. The kind of work being done by creative mathematicians during the early decades of this century was qualitatively different from what was done a century before and was both more powerful and broader in scope.

"During the period between the two World Wars, it became clear that this way of looking at mathematics--first making sure that the basic ideas were clear and understandable and then investigating the ways they fit together--was equally useful in education at the graduate level. By 1940 graduate texts taking this point of view were in the majority, and after World War II the movement spread to the undergraduate program.

"When, in the late fifties, university mathematicians indicated a willingness to assist in the improvement of precollege mathematics, they naturally suggested that the point of view that had proved so successful at higher levels be tried at the secondary school level, and when it seemed to work there, that it be tried at the elementary school level as well." (page 27)

The curriculum development model used in producing many of the major American New Math programs was the Research-Development-Diffusion model. (House, 1979; Howson, 1979) A case history of the application of this paradigm may be found in Wooton (1965) where he describes the early work of SMSG. Briefly, their materials were produced in the following way: a team of mathematicians and teachers would meet for a number of weeks to discuss objectives and write materials. These materials would then be tried out in a number of schools and revised. Finally, the materials were made available for general use. In the case of SMSG and several other projects, financial support was provided mainly by the federal government.

The influence of SMSG on the North American mathematics curriculum has been pervasive, and many textbook series, whether at the elementary or the secondary level, are pat-

terned after their SMSG counterparts. Indeed, many of the authors of contemporary mathematics texts in the United States were, at one time or another, involved in SMSG writing teams.

O'Brien (1973) refers to the important role played by SMSG in describing the content of mathematics at the elementary school level in North America. He says:

> The goals of present elementary school mathematics programs--derived largely from the publications of the School Mathematics Study Group--involve an understanding of the principles of the rational number system and the interrelatedness of various subsets of the rationals, the use of underlying principles such as associativity and distributivity in support of proficiency in computation and, to a lesser extent, a knowledge of nomenclature and notation in geometry. (pages 258-259)

At the secondary school level, the following quotation from the Preface to one of the SMSG texts, Mathematics for Junior High School, Volume I, provides a brief summary of the flavor of the materials produced by the project:

> Key ideas of junior high school mathematics emphasized in this text are: structure of arithmetic from an algebraic viewpoint; the real number system as a progressing development; metric and non-metric relations in geometry. Throughout the materials these ideas are associated with their applications. Important at this level are experience with and appreciation of abstract concepts, the role of definition, development of precise vocabulary and thought, experimentation, and proof. Substantial progress can be made on these concepts in the junior high school. (page v)

The two most widely-used mathematics textbooks at the Grade 8 level in British Columbia at the present time are School Mathematics II (Addison-Wesley) and Mathematics II (Ginn and Company). Results from a survey of teachers conducted as part of the 1977 B.C. Mathematics Assessment reveal that about fifty-five percent of the teachers of Grade 8 mathematics in the province made use of the former, and an equal number used the latter (Robitaille and Sherrill,

1977).[15]

Both of these texts owe their origins to SMSG materials. As the authors of Mathematics II state, "the series incorporates many of the recommendations of experimental groups such as the School Mathematics Study Group, where one of the authors has served as a panelist and both have served as members of writing teams." (page v) They go on to describe the contents of the text as follows:

> Mathematics II is designed to continue the student's work in secondary mathematics, and it offers a sound and thorough preparation for subsequent formal courses in algebra and geometry. Significant attention is directed to the structure of mathematics, to the fundamental ideas underlying the familiar practices and procedures of arithmetic, and to the properties and relations of algebra and geometry. (page v)

The chapter titles in the text are Integers and Rational Numbers; Exponents and The Pythagorean Property; Decimals and Real Numbers; Constructions and Congruency; Equations and Inequalities; The Coordinate Plane; Formulas and Functions; Prisms and Pyramids; Cylinders, Cones, and Spheres; Probability and Statistics; Similar Figures and Trigonometric Ratios. School Mathematics II contains similar material.

It is difficult to determine the nature of the curriculum model now prevailing in the United States. For a number of reasons, including criticism from mathemacicians (e.g. Kline, 1974; Ahlfors and others, 1962) and concerns about purportedly serious declines in standards, there has been a clear move away from much of the New Math content. It is less clear in what direction the curriculum is now heading.

The NACOME[16] report contains a strong rebuttal of criticisms such as those by Kline in his book Why Johnny Can't Add (1974). The report defends the changes made between 1955 and 1975 by saying that "from a 1975 perspective the principal

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[15] The total exceeds 100% because teachers are encouraged to make use of several authorized texts with their mathematics classes.

[16] NACOME is the acronym for the National Advisory Committee on Mathematical Education which was established by the Conference Board of the Mathematical Sciences in the U. S. A. in 1974.

thrust of change in school mathematics remains fundamentally sound, though actual impact has been modest relative to expectations." (page 21)

The report goes on to discuss current programs and issues. Noting that most New Math programs were directed at the more able students, the report lists the following areas of current concern: "programs for less able students", "minimal mathematical competence for effective citizenship", "interaction of mathematics and its fields of application", and "the impact of new computing technology on traditional priorities and methods in mathematics". (page 23) A similar list of priorities for the 1980s was published recently by the NCTM (1980). They propose that:

- problem solving be the focus of school mathematics in the 1980s;
- basic skills in mathematics be defined to encompass more than computational facility;
- mathematics programs take full advantage of the power of calculators and computers at all grade levels;
- the success of mathematics programs and student learning be evaluated by a wider range of measures than conventional testing;
- more mathematics study be required for all students and a flexible curriculum with a greater range of options be designed to accomodate the diverse needs of the student population. (page 1)

It would appear that the NCTM, in referring to "basic skills", is attempting to put the widespread demands for a renewed emphasis on computational skills into a broader perspective. While it would be an exaggeration to say that mathematics instruction in schools has historically meant drill in arithmetic skills, there is no denying the fact that the Basic Mathematics model has held a pre-eminent position in mathematics education in North America ever since elementary education became universal at the turn of the century. At the secondary school level, this model may be seen in the heavy emphasis accorded to the development of manipulative techniques in algebra. This emphasis has been questioned on a number of occasions over the last eighty years by mathematicians, mathematics educators, and by their professional associations. They have sought, on these occasions, to moderate the stress placed on what might be termed a narrow,

utilitarian, skill-centred, school mathematics curriculum.[17]

There is no doubt that, at the present time, the mathematics curriculum in North America is undergoing serious scrutiny and that some fundamental changes will be made in the 1980s. O'Brien (1973) summarizes many of the basic questions and issues which must be faced in the near future. He asks:

> What is the usefulness in the life of a child--or in the life of the adult he will become--of an understanding of the structure of the rational number system? What is the usefulness of a "knowledge" of facts, rules, and procedures of number? What is the marketability of computational skill when thousands of error-free long divisions, for example, can be performed by a computer in a few seconds at a cost of a few cents? What is the usefulness in the life of a child or an adult of a "knowledge" of the nomenclature and the notation of elementary geometry? (page 259)

In other words, while it is true that the Basic Mathematics model has been of central importance to the North American mathematics curriculum throughout this century, it may well be that the increasing impact of technological factors will necessitate a reconsideration of the amount of emphasis which that model should receive.

Summary

Three models for the mathematics curriculum which are in widespread use today are the so-called Pure Mathematics model, the Applied Mathematics model, and the Basic Mathematics model. A particular curriculum will typically include aspects of all three models, with one receiving greater emphasis than the other two. This emphasis might vary from one grade level to the next.

In France, the Pure Mathematics model is pre-eminent, and the basic direction and content of their curriculum appears to be fairly firmly established. In Great Britain, the Applied Mathematics model is predominant. In North America, there has been a clear move away from the Pure Mathematics model which prevailed during the New Math era. It is less clear at this

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[17] See, for example, the volume produced by the Progressive Education Association in 1940, Mathematics in General Education.

time which model will be the predominant one in the near future, although some trends are discernible.

There is a certain amount of pressure, for example, to implement a curriculum which emphasizes the Basic Mathematics model. Advocates of the "back-to-basics" movement stress the importance of computational skills and of preparing students to function as "enlightened consumers in a technological society." Teachers of mathematics, as well as others involved in the field of mathematics education, have reacted to this pressure, not by attempting to belittle the importance of the "basics", but rather by proposing to expand the list of basic skills to include such topics as probability and statistics, and computer literacy.[18]

At the same time, there is a movement to assign higher priority to problem solving and the applications of mathematics. The NCTM has, in the last few years, published a two-volume text entitled <u>Algebra through Applications</u> (Usiskin, 1979); three yearbooks, <u>Applications in School Mathematics</u> (Sharron, 1979), <u>Problem Solving in School Mathematics</u> (Krulik, 1980), and <u>Teaching Statistics and Probability</u> (Shulte (1981); and a reference text, <u>A Sourcebook of Applications of School Mathematics</u> (Bushaw, 1980). Moreover, the topic of problem solving was listed by the NCTM (1980) as the number one priority for the teaching of mathematics in the 1980s.

2.4 Implications for Curriculum Revision

The mathematics curriculum may, for the sake of analysis, be viewed from three different perspectives. Thus, we may distinguish among the curriculum as <u>intended</u>, the curriculum as <u>implemented</u>, and the curriculum as <u>attained</u>. By the <u>Intended Curriculum</u> is meant the curriculum as planned at the provincial level by curriculum committees and consultants, and as codified in the curriculum guide. The Implemented Curriculum is the curriculum as contained in the various texts and materials which are selected and approved for use in the schools and as communicated to students by teachers in their classrooms. The Attained Curriculum is the curriculum as learned and assimilated by the students. It has been argued elsewhere (Robitaille, 1980) that discrepancies exist among these three versions of the curriculum in British Columbia and in other

[18]See, for example, the article entitled "Position Statements on Basic Skills" in the February 1978 issue of <u>The Mathematics Teacher</u>.

parts of the world as well.

Most of the mathematics textbooks, that is the Implemented Curriculum, used in British Columbia are Canadianized versions of textbooks published in the United States, and, as the discussion earlier indicated, their goals and content have been strongly influenced by those of the SMSG publications. On the other hand, the B.C. curriculum guide (Curriculum Development Branch, 1978), the document which sets out the Intended Curriculum, says that:

> Before any formal mathematics can be understood there must be a wealth of manipulative experiences through which concepts and relations are understood at an intuitive level. Mathematics as a discipline, as a formal structure, must be built upon a sound foundation of concrete experiences. Formal study of mathematics as a structured discipline is the function of post-elementary education (page 1).

The guide goes on to say that "at the elementary level it is important [that] the mathematics program include facts, computation, and processes." (page 1)

The specific content objectives listed in the curriculum guide for each grade are not obvious outgrowths of the kinds of global goals just mentioned, nor is it clear how mastery of these specific content objectives will result in attainment of those goals.

The list of specific objectives given for each grade is lengthy and contains both the old and the new. Topics such as sets, geometry, variables and functions, consumer mathematics, and vectors have been included but all of the customary topics (Roman numerals, long division, factoring, ...) are there as well. The curriculum is crowded with topics to be taught and mastered, and the curriculum guide provides little, if any, specific information to teachers to assist them in determining the appropriate methodology or even the best textbook to use. Indeed, since several texts have been authorized for use at each level, the specific objectives for a given grade do not necessarily coincide very well with any one of those texts.

The present situation, then, is one in which there appear to be important differences between the Intended Curriculum and the Implemented Curriculum. Moreover, data collected recently in connection with a test-development project (Robitaille, Sherrill, and O'Shea, 1980) indicate the existence of possibly serious discrepancies between the Intended Curriculum and the Attained Curriculum (Robitaille, 1981).

If the mathematics curriculum in this province needs improving, and the facts as presented here would appear to justify such an opinion, then care must be taken to design a curriculum development procedure suited to the task. In particular, every effort should be made to reduce the disparity among the Intended, the Implemented, and the Attained Curricula and, equally important, to ensure that the question of what content is appropriate and necessary be faced squarely.

In an article in The Mathematics Teacher, Usiskin (1980) argues that if topics such as computer literacy, applications, statistics, and geometric transformations are to be added to the mathematics curriculum of the schools, some existing content will have to be eliminated. Certainly, one cannot attend mathematics conferences or read professional journals and not reach the conclusion that content relating to mathematical modelling, applications, statistics, computers, calculators, and problem solving will play an increasingly important role in the mathematics curriculum of the 1980s. Moreover, one cannot help but agree with Usiskin that the hope of the 1960s that "structure, deductive reasoning, and unifying ideas would enable some topics to be dealt with more quickly and more easily" (page 414) and thus not require extensive deletions of traditional material has not been realized. Such a position now seems more than a trifle naive. Bruner's (1973) vision that increasingly powerful theories create a knowledge implosion which structures the more perceivable explosion of new facts remains a pious hope within the setting of real schools and classrooms.

Usiskin is also quite correct in saying that, in the process of curriculum revision, criteria for deciding which content is to be included must be developed in order that new material can be added and, equally important, in order that some traditional content can be excluded. Unfortunately, the problem facing us is even more complicated, and its solution will require more than the formulation of content-oriented selection criteria. It is essential that if, for instance, problem solving is to become a major focus of the mathematics curriculum, consideration be given to which views of mathematics and mathematical presentation are consistent with that focus. Additional criteria regarding the selection of

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[15]Comprehensive schemes such as that described by Eraut, Goad, and Smith (1975) may provide useful analytic tools for those charged with the task of curriculum revision. However, the curriculum development and learning theory assumptions which underlie any such scheme must be carefully examined.

materials[19] and the training of teachers must also be considered. As Confrey (1980) has observed:

> ot only does one's understanding of one's discipline affect profoundly what content is selected for presentation, but it also affects how that content is presented. The impact of one's theory(ies) of knowledge is both on the content and method of presentation and the interaction between these two cannot be ignored. (page 21)

Finally, the various aspects of the curriculum development process must be considered if revision is to be meaningfully implemented. Returning to the example of problem solving, one must consider the linkage between the desired learning outcomes and any commitment to, say, behavioral psychology or behaviorally derived mastery learning programs. In short, the curriculum revision process must seek to identify and make allowances for the various aspects of and relationships within the mathematical and educational systems.

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CHAPTER 3

THE GOALS SURVEY

David F. Robitaille

Six Review Panels[1] composed of members of the public, school trustees, and educators were set up by the Learning Assessment Branch to participate in the Goals Survey. Two Panels discussed the goals of the mathematics curriculum at the primary grade level, two at the intermediate level, and two at the secondary level. The day-long meetings of the Panels were held in Kelowna, Prince George, Qualicum, and Richmond during the fall of 1980.

The Goals Survey was intended to provide a forum for discussing the goals of the mathematics curriculum in B. C. In preparation for the meeting of their Review Panel, participants were asked to read the Curriculum Models paper and to complete the Goals Survey questionnaire.[2] The questionnaire was divided into four major sections: goals of mathematics education, content of the curriculum, organizing for instruction, and process and affective objectives.

Each of the Panels experienced considerable difficulty in reaching agreement on the meaning of some of the terminology used in the questionnaire. Although terms such as "logical thinking", "specialist", and "computer literacy" are widely used, it was apparent that different Panelists held widely different views about their meanings. This lack of agreement, more obvious in this kind of forum than in data obtained through questionnaires, constitutes a real limitation of such surveys of opinion and preferences.

This chapter contains a summary of the discussions and deliberations of the Review Panels. Because there were only about 90 Panelists in all, no statistical analyses of the results were undertaken. Any conclusions reported here may be interpreted as representing the prevailing opinion of this group of people selected to represent both the different geographic zones of the province as well as the different segments of the population having an interest in the mathema-

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[1]The names of the members of the Review Panels are listed in Appendix B.

[2]The Goals Survey questionnaire is reproduced in Appendix E.

tics curriculum of the schools.

A number of items from the Goals Survey questionnaire also appeared on the Teacher Questionnaires which were completed by elementary and secondary teachers as part of the Assessment. For those common items, the Teacher Questionnaire results are presented in this chapter as a complement to the opinions expressed by the Review Panels.

3.1 Goals of Mathematics Education

The first section of the Goals Survey questionnaire set the tone for the remaining portions and was intended to stimulate Panelists' thinking about some of the major questions which will have to be answered in any review or revision of the present mathematics curriculum. Panelists were given lists of goals for education in general and for mathematics education in particular. They were asked to rank those goals in order of importance, and to make additions to the lists as they saw fit.

All six Review Panels ranked the same two overall goals of education as being most important:

- to prepare students to live in society.
- to have students acquire basic knowledge such as reading, writing, and mathematics.

Regarding the goals of mathematics education, each of the Panels agreed that teaching "students the mathematical concepts and skills required to function as enlightened consumers in a technological society" was of primary importance. Also highly ranked by all were the goals of familiarizing students with the major ideas and processes used in mathematics, and developing in students the ability to "think logically".

The Teacher Questionnaires, both elementary and secondary, contained virtually the same list of goals for mathematics education as did the Goals Survey questionnaire[3], and teachers were asked to rate each on a four-point scale ranging from Not Important to Essential. Over 90% of both groups of teachers rated the development of the skills required to function in society and of the ability to think logically as being either

[3]There were seven goals listed on the Goals Survey instrument and eight on the Teacher Questionnaires.

important or essential goals for school mathematics.

3.2 Content of the Curriculum

Panelists were asked to rate the importance of a number of broad topic areas first for the mathematics curriculum of the elementary school and then for the secondary school. The list included the following topics:

- mathematical concepts
- arithmetic skills
- algebra
- geometry
- consumer mathematics
- applications
- structure and properties
- measurement
- problem solving

All six Panels rated the topics of mathematical concepts and problem solving as being essential to the mathematics curriculum of both the elementary and the secondary school. Arithmetic skills were also rated as essential at the elementary level, and algebra at the secondary.

In general, results from the Teacher Questionnaires support the opinions expressed by the Review Panels. Over 90% of elementary respondents said that the topic of arithmetic skills received a great deal of emphasis in their classes and agreed that the topic should continue to be accorded that degree of emphasis. According to 70% of the elementary teachers, mathematical concepts should also be emphasized, and the same proportion said that it was emphasized in their classes. Seventy percent said that problem solving should be emphasized, but less than 50% said that they did so with their students.

Among secondary teachers responding to the Teacher Questionnaire, slightly more than 60% said that algebra should be heavily emphasized in the mathematics curriculum. This was the only topic selected for emphasis by a majority of the respondents.

The Review Panels then moved on to a discussion of the "back-to-basics" question and the meaning of the term "basic". On this issue, the National Council of Teachers of Mathematics (1980) has recommended that "basic skills in mathematics be defined to encompass more than computational facility." (page 1) Such a definition was provided by the National Council of Supervisors of Mathematics (1978) of the United States. They listed ten "basic skills" of mathematics:

- problem solving
- applying mathematics in everyday situations
- alertness to the reasonableness of results

- estimation and approximation
- appropriate computational skills
- geometry
- measurement
- reading, interpreting, and constructing tables, charts, and graphs
- using mathematics to predict
- computer literacy

Panelists were provided with this list of topics and a brief definition of the meaning of each. They were asked to rate the importance of these topics on a four-point scale ranging from Not Important to Absolutely Essential, and to select the three most and the three least important ones for their particular grade level.

All six Review Panels rated alertness to the reasonableness of results, computational skills, and problem solving as being either Very Important or Absolutely Essential at their level, as well as for the mathematics curriculum in general. Computer literacy and using mathematics to predict received the lowest rankings.

To round out the section on the content of the school mathematics curriculum, Panelists were asked to suggest topics which should be dropped from the British Columbia curriculum as well as as topics which should definitely be included in any future curriculum. Panelists appeared to find this to be a difficult task, and few of them made recommendations outside their own grade level. There appeared to be some degree of agreement that topics such as Roman numerals, fractions, and early emphasis on the use of abstract symbols should be deleted from the primary curriculum; that Roman numerals, transformational geometry*, and any emphasis on sets and set operations be deleted from the intermediate curriculum; and that sets and set operations, graphs of inequalities, and the formal unit on vectors be dropped from the junior secondary curriculum. All three Panels agreed that less emphasis should be given to the study of common fractions in the elementary school.

The only topics whose inclusion in a future curriculum was recommended by all three Panels were problem solving and computer literacy although, in the latter case, there was some disagreement as to the best level at which to introduce the

*This might include, for example, the study of symmetry, translations (slides), reflections (flips), and rotations (turns).

topic. The Review Panels at the primary level felt that problem solving, decimals, and work with concrete materials should be emphasized. The Intermediate Panels felt that more attention should be paid to the study of geometry and the use of calculators. One of the secondary Review Panels recommended that the Grade 12 curriculum include a unit on calculus.

3.3 Organizing for Instruction

The third section of the Goals Survey questionnaire dealt with a number of issues that could affect the way in which mathematics is taught in British Columbia and to whom it is taught.

Grouping of Students

Whether or not it is beneficial to students' achievement in mathematics to use some form of ability grouping or streaming, either within or between classes, is a question that has been debated for decades. Begle (1979) summarized the results of all the research that has been done in the area by stating that "for all but the most able students, it seems to make little difference whether they are grouped homogeneously or not" (page 106).

All of the Review Panels came out in favor of ability grouping by classes in mathematics at the secondary level, and within classes at the elementary level. All were opposed to placing students in classes at the elementary level on the basis of their mathematics ability. There was no general agreement on whether or not all students, regardless of ability, should follow the same basic mathematics program through Grade 10 as prescribed in the present curriculum. The secondary Panels opposed the continuation of this practice, but the others failed to reach a consensus.

Specialization of Students

In some countries, students at the senior level are either expected or required to concentrate on a small number of subjects and to pursue them in some depth. Thus, as was mentioned in Chapter 2, a student might spend a considerable proportion of his school time each week studying mathematics. Panelists were asked to list the possible advantages and disadvantages of implementing a program which would enable students at the senior secondary level to concentrate their studies in this way.

All of the Panels agreed that such a program might be beneficial for the most capable students. However, they also

felt that early specialization of students should not be encouraged and that the schools should emphasize general education through Grade 12.

Semestering of courses

Many secondary schools in British Columbia operate on a semester system. Under this system, a student might complete an entire mathematics course during the first half of the school year, and then not study any mathematics at all in the second semester. This practice, as was mentioned in Chapter 2, is virtually unheard of below the Grade 12 level in other parts of the world, and its pros and cons have been the subject of some controversy here. Panelists were asked to comment on the advantages and disadvantages of the semester system for the teaching of mathematics.

In the opinion of the Panelists, the advantages of semestering seem to be that it affords a greater degree of flexibility in constructing the timetable for the school, that more courses can be offered, and that it permits students to make up courses without spending an extra year in school. Panelists felt that one of the major disadvantages of semestering mathematics courses was that the courses were too concentrated, leaving the students insufficient time to digest new material. Moreover, they felt that the time-lapse between one course and the next, up to one year in some cases, was too long, and that students would therefore not be well-prepared for subsequent courses. The advantages which were identified tended to emphasize administrative rather than pedagogical concerns, whereas the disadvantages appeared to be mainly pedagogical.

Compulsory Mathematics Courses

At the present time all students in B. C. are required to study mathematics up to Grade 10. When Panelists were asked to comment on that policy, a clear majority stated that some type of mathematics course should be required of all students every year from Grade 1 to Grade 11. There was some disagreement about requiring mathematics of all Grade 12 students or in Kindergarten. It was clear that the Panelists felt that there should be a variety of courses available, especially at the senior levels, and that not all students should be required to follow academic courses.

Specialization of Teachers

It proved to be rather difficult to discuss the use of specialists for the teaching of mathematics because of the differing opinions which Panelists held about the meaning of the term. Some felt the word described a person with a fairly

comprehensive background in mathematics and the teaching of mathematics. Others took the term to mean a person who spent a significant part of his time teaching mathematics but who might or might not have an extensive academic background in the subject and its associated methodology.

There was widespread agreement that the teaching of mathematics should be consigned to well-trained specialists at least at the junior and senior secondary levels. Moderate support for that view was evident for the teaching of mathematics in elementary school. One Panel recommended that every elementary school have at least one mathematics specialist on its staff who could serve as a resource person for the other teachers.

Responses to this same item on the Teacher Questionnaires produced more clear-cut results, as shown in Table 3-1. An overwhelming majority of teachers, both elementary and secondary, support the use of specialists for teaching mathematics in secondary school. There is moderate support for the use of specialists at the primary level and stronger support for their use at the intermediate level. In both of these latter cases, however, majority of the respondents did not support the idea.

Table 3-1
Percent of Teachers Supporting the Use of Specialists to Teach Mathematics

Level	Elementary Teachers	Secondary Teachers
At no level	2	3
Primary	16	25
Intermediate	32	47
Junior Secondary	88	77
Senior Secondary	85	93

As in the case of the Review Panels, the word "specialist" was not defined on the Teacher Questionnaires. For that reason these results should be interpreted cautiously.

Calculators

The discussion of the place of calculators in the mathematics classroom provided an opportunity for Panelists to air a number of concerns they had about possible misuses of these

devices by students. In keeping with the strong feelings about the importance of computational skills which they had expressed earlier, many Panelists initially resisted the idea of using calculators in elementary schools. After some discussion of ways in which calculators might be used beneficially, even at the primary level, all of the Review Panels supported their use in schools. However, their concerns about computational skills remained, and they were strongly of the opinion that the development of such "paper-and-pencil" skills must remain a major goal of the elementary school mathematics curriculum.

Similar opinions were expressed by teachers of mathematics in response to one of the Teacher Questionnaire items. Those results are shown in Table 3-2.

Table 3-2
Percent of Teachers Supporting the Use of Calculators in Mathematics Classes

Level	Elementary Teachers	Secondary Teachers
At no level	7	5
Primary	15	10
Intermediate	36	20
Junior Secondary	64	56
Senior Secondary	81	91

If anything, these results show less support for the use of calculators than that expressed by the Review Panels, particularly at the elementary level. One possible reason for this rather conservative position is that teachers fear that the introduction and indiscriminate use of calculators will result in a deterioration of students' abilities to apply the standard computational algorithms.

Computer Literacy

The term "computer literacy" is in widespread use and, as so often happens, it is subject to many different interpretations. On the Goals Survey questionnaire and on the Teacher Questionnaires it was defined to mean a general awareness of the role and function of computers as well as of their strengths and limitations as they are used in our society. It was not intended to include such technical aspects of computing as programming or data analysis.

All of the Review Panels were of the opinion that computer literacy had a place in the school curriculum, but not necessarily as a part of the mathematics curriculum. The majority felt that the topic should be dealt with in a number different courses, including social studies, science, and accounting, as well as mathematics. The second most prevalent opinion was that a new course in computer literacy should be introduced in the schools.

Similar opinions were expressed by respondents to the Teacher Questionnaires. Virtually all of them felt that computer literacy should be part of the curriculum. The largest group, about 40% of all of those responding, felt that it should be taught as part of several existing courses rather than as a separate course or a part of the mathematics curriculum.

3.4 Process and Affective Objectives

In the educational literature, a distinction is commonl made between process and product objectives. The latter are those objectives which deal with the specific items of content to be taught or learned. The former go beyond the specific content of courses to get at problem solving strategies, for example, and other mental abilities that the learning of mathematics is believed to enhance. An example of a widely-held process objective is that the study of mathematics will enhance students' ability to "think logically".

The development of positive attitudes and self-concept are also important parts of the teaching and learning of mathematics. Such affective outcomes are notoriously difficult to specify and evaluate, but there seems to be a growing awareness of their importance and of their relationship to students' achievement.

The Review Panelists were given a list of process and affective objectives for mathematics, and they were asked to rate the importance of each on a four-point scale ranging from Not Important to Absolutely Essential. That list, which is reproduced below, is not an exhaustive one, but it does deal with some of the concerns which have been raised in this regard.

- The ability to analyze and conceptualize problems.

- The ability to apply skills and strategies to new situations.

- The ability to discover patterns and similarities.
- An attitude of curiosity and exploration.
- A number of problem-solving strategies.
- The process of logical reasoning.
- The ability to formulate key questions.
- The ability to gather, organize, and interpret data and communicate results.
- A positive attitude toward mathematics.
- An improved degree of confidence in their ability to use mathematics as a tool to solve real-life problems.
- A sense of enjoyment of mathematics.
- The ability to make intelligent guesses.
- The ability to read with comprehension.

All thirteen of the proposed objectives were rated as Very Important or Absolutely Essential by each of the Review Panels, although there were a number of comments about the likelihood that things such as curiosity, positive attitudes, and enjoyment can be taught. Members of the primary Panels felt that students also need to learn the value of persistence and exer ion, that real-life problems are often complex and not amenable to simplistic solutions.

The major difficulty with a discussion of process and affective objectives is determining how these objectives can be attained through the medium of the product objectives which define the content of the curriculum. As was suggested by the Review Panels at the intermediate level, it is difficult to see the relationship between the objectives listed here and the content identified as being important. For example, it may well be absolutely essential for teachers of mathematics to aim at the development of their students' ability to think logically, whatever that means. It is not at all clear. however, what content should be used to achieve that objective, how that content should be taught, or if the logical thinking ability developed through the study of mathematics will transfer to non-mathematical situations.

3.5 Summary

The task of the Review Panels was a difficult one, as might have been expected. They were asked to consider the advantages and disadvantages of the alternatives described in the Curriculum Models paper even though these may have been outside their personal experience. Since these descriptions were necessarily sketchy, and since many of the Panelists encountered much of the material discussed for the first time when they read that paper, it is not surprising that no radical departures from current practice were suggested.

In the opinion of the Panelists, the mathematics curriculum should emphasize one major theme: developing in students the abilities, concepts, and skills they will need in order to participate successfully in our complex society. This included having a high degree of proficiency in computational skills as well as being able to apply the skills and techniques of mathematics in real-life situations. In terms of the models defined in the Curriculum Models paper, the Panels seemed to be advocating the adoption of a combined Applied Mathematics-Basic Mathematics model. There was little support for emphasizing any sort of Pure Mathematics model at any level. However it is not possible to decide whether or not such a lack of support was a reaction to purported excesses or inappropriate emphases of the New Math, or to a belief that a curriculum based to any large extent on the Pure Mathematics model is inappropriate.

The Goals Survey was also conducted with the Mathematics Advisory Committee (MAC), a committee established by the Ministry of Education to advise the Curriculum Development Branch and the Learning Assessment Branch on matters affecting the teaching and learning of mathematics in British Columbia. The members of this committee are selected to represent all levels of public schooling, as well as the colleges and universities.

On the whole, the opinions expressed by the members of MAC were very similar to those of the Review Panels. They emphasized the importance of problem solving and the necessity of educating students to be enlightened consumers. They were somewhat more inclined than the Review Panels to recommend that mathematics be taught by specialists, even at the primary grade levels. Process objectives were considered to be very important but the committee members felt that affective outcomes and enjoyment of mathematics should be given lower priority.

In the deliberations of the Review Panels and MAC, it was apparent that there is no consensus about the place of geome-

try in the curriculum, except that it is not seen as being of top priority. Moreover, there does not appear to be any agreement on reasons for including geometry in the curriculum, either elementary or secondary, or on appropriate geometric content and teaching methodology. This is a matter which the Curriculum Development Branch should address in the very near future.

3.6 References

Begle, E. G. Critical Variables in Mathematics Education. Washington, D. C.: Mathematical Association of America and National Committee to Curriculum Development and Learning Assessment of Teachers of Mathematics, 1979.

National Council of Teachers of Mathematics. An Agenda for Action: Recommendations for School Mathematics of the 1980s. Reston, Virginia: National Council of Teachers of Mathematics, 1980.

National Council of Supervisors of Mathematics. Position statement on basic skills. The Mathematics Teacher, 1978, 71. 147-152.

CHAPTER 4

INSTRUMENTATION AND SAMPLING

Thomas O'Shea

In the 1981 Mathematics Assessment information was collected about students' achievement in mathematics, their attitudes toward the subject, and aspects of their personal backgrounds. This information was obtained using instruments developed specifically for the students and curriculum of British Columbia. The instruments required 45 minutes to administer and were divided into three sections--background information, attitudes toward mathematics, and mathematics achievement.[1] Technical issues related to the development of the instruments and the question of sampling are dealt with in this chapter of the report.

4.1 Background Information

There is increasing evidence that performance in mathematics is related to specific characteristics of the student (Begle, 1979, page 85). For example, the differential performance of males and females is of particular interest at the present time. In order to obtain information on this and other issues, students were asked to provide personal information such as age, gender, whether English was their first language, and the extent of calculator usage. As a result, it was possible to analyze achievement and attitude data on the basis of "reporting categories" within each of these variables. Other questions, dealing with topics such as the plans of Grade 12 students for enrolling in particular post-secondary institutions, were added on the basis of requests from various branches of the Ministry of Education.

The background information section of the instruments was also used to provide information about the extent to which students have adopted the metric system. Students were asked to state which units, metric or imperial, they would use in four practical situations.

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[1]The instruments are reproduced in Appendices F, G. and H.

4.2 Attitudes toward Mathematics

In a review of 93 research studies on mathematics attitudes, Begle (1979) found that half of the studies simply measured students' attitudes toward mathematics. He concluded that mathematics is neither the most strongly liked, nor disliked school subject; rather, the average student's attitude toward mathematics is a neutral one. He also found that when students reach secondary school their attitudes toward mathematics gradually become more negative. Finally, Begle suggested that there is a significant positive correlation between attitude and achievement. However, he pointed out that the relationship is not as strong as many people contend, and it was not evident in every study.

In a similar review, Kulm (1980) cited Crosswhite (1972) to the effect that there is a low positive relationship between attitude and achievement. Kulm suggested that studies concerning attitudes toward mathematics are spurred by the belief that there may be a causal relationship between such attitudes and achievement. That is, by inducing student enthusiasm for mathematics, teachers can increase student performance in the subject.

The attitude scales used in this Assessment were derived from scales developed by the International Association for the Evaluation of Educational Achievement (IEA) for inclusion in the Second International Study of Mathematics, and by NAEP for use in their 1978 assessment of mathematics. Initially, two scales appeared to be suitable. The first scale, Mathematics as a Process, consisted of fifteen items and was intended to measure students' feelings about the nature of mathematics. For each item students were asked to express their agreement or disagreement with statements such as "Learning mathematics involves mostly memorizing." This scale, which originally contained 23 items, had been piloted internationally for the IEA study and showed generally acceptable reliabilities (coefficient α) ranging from 0.56 to 0.75 for Grade 8 students and 0.49 to 0.91 for Grade 12 students. However, reviewers from various countries had criticized the scale because of the difficulty of the language in the items and because of the ambiguity of certain items even when the language presented no problems.

The second scale, Mathematics and Myself, consisted of 19 items designed to gauge students' reactions to the study of mathematics. The scale provided a description of the extent to which students found mathematics enjoyable, and to which they felt competent to do mathematics. Reliabilities reported for this scale, which originally contained 24 items, in the IEA pilot studies were high, ranging from 0.83 to 0.91 for Grade 8

students, and from 0.71 to 0.95 for Grade 12 students. However, the deletion by IEA of some items and the rewording of others left some doubt as to whether the remaining items would function adequately as a scale.

The two scales were included in the pilot testing phase of the 1981 Assessment to determine their suitability. As well, a subset of eight items from the Mathematics and Myself scale was selected for pilot testing at the Grade 4 level. The results obtained are shown in Table 4-1.

Table 4-1
Attitude Scale Results from Pilot Tests

	Math as a Process		Math and Myself	
	n	Reliability*	n	Reliability*
Grade 4	-	-	1453	0.68
Grade 8	728	0.50	714	0.88
Grade 10	48	0.48	49	0.88
Grade 12	227	0.56	225	0.92

*Hoyt estimate of reliability

The results for Mathematics and Myself indicated that the scale was psychometrically acceptable at all grade levels. At the Grade 4 level, only two students failed to respond to the set of items, and a maximum of sixteen failed to respond to a particular item.

On the other hand, the results for the Mathematics as a Process scale were unacceptable. Further analysis of this scale failed to provide evidence of appropriate conceptual structure, and the scale was finally abandoned.

For the Assessment, the Mathematics and Myself scales were used as piloted. Analysis of the Grade 10 responses and a ten percent sample of responses selected from each of the other grade levels yielded the results shown in Table 4-2, corroborating the reliabilities obtained in the pilot study.

Table 4-2
Attitude Scale Results from the Assessment

	Number of Responses*	Reliability**
Grade 4	3067	0.73
Grade 8	3301	0.87
Grade 10	2456	0.89
Grade 12	2558	0.90

*Based on a 10% sample for Grades 4, 8, and 12.
**Hoyt estimate of reliability.

4.3 Achievement Items

Construction of the achievement portion of the instruments involved a number of tasks: determining the domains and objectives at each grade level, generating test items, pilot-testing, and selecting the final items.

Item Generation

The content domains for this Assessment were determined by the Contract Team, with the assistance of the Advisory Committee. Within each domain, a number of objectives were identified and an attempt was made to standardize these across grades. The domains and their associated objectives are shown in Table 4-3.

Most of the items used were related to topics from the prescribed curriculum in B. C.; however, a number of items addressing content from outside that curriculum were also included. Where appropriate, items were drawn from existing sources such as the National Assessment of Educational Progress (NAEP, 1979), the Second International Study of Mathematics (IEA, 1980), and the British Columbia Mathematics Achievement Test project (Robitaille, Sherrill, Kelleher, and Klassen, 1979). Items were also chosen to reflect a wide range of difficulty in order that students of varying levels of ability would be challenged.

Other considerations also guided item selection. It was intended that it should be possible to report on broad topics across domains, such as problem solving and consumer mathematics. Comparison of performance with the first assessment was required, and although not a priority, cross-grade comparisons were to be possible.

Table 4-3
Domains and Objectives

Domains	Objectives Grade 4	Grade 8	Grade 12
1. Number & Operation	Number concepts & computation	Whole numbers	Number concepts
	Estimation	Fractions & decimals	Fractions & decimals
	Fractions & ratio	Ratio, proportion, & percent	Ratio, proportion, & percent
2. Geometry	Geometric figures	Geometric figures	Geometric figures
	Geometric relationships	Geometric relationships	Geometric relationships
		Logical reasoning	Logical reasoning
3. Measurement	Length, area, volume, mass	Metric units	Metric units
	Time & temperature	Area & volume	Area & volume
4. Algebraic Topics	Equations	Expressions, equations, & inequalities	Expressions, equations, & inequalities
	Graphs	Graphs	Graphs
	Probability	Probability	Probability
		Statistics	Statistics
5. Computer Literacy			

Sufficient items, in roughly double the proportion to their representation on the final instruments, were collected and made ready for pilot testing.

Pilot Testing

In October 1980, a sample of schools was selected to administer the items in order to provide statistical data together with students' and teachers' comments on the suitability of the items. The sample drawn for piloting was subject to constraints imposed by the decision taken by the Ministry of Education in this Assessment to test only samples of students in the larger school districts.

For the pilot study, six test forms were assembled at each of the Grade 4 and Grade 8 levels, and three at the Grade 12 level. For each test form, a sample of ten classes was selected. In addition a small number of Grade 10 classes was

selected to write the Grade 12 forms since a sample of Grade 10 classes was to be included in the Assessment.

As much as possible, pilot classes were selected so that the number of classes drawn was proportional to size of geographic zone and, within school districts, to district size. Within a district, an attempt was made to select schools differing in numbers of students having English as a second language. Classes participating in the IEA study were excluded from eligibility for pilot sampling. Where possible, a school which was selected for one grade was also selected for another grade. This was done since schools selected for piloting were to be excused from participating in the Assessment proper. In those secondary schools selected, either two or three classes wrote the pilot tests whereas all students in Grade 4 in the elementary schools selected were tested. Details of the pilot testing are shown in Table 4-4.

Table 4-4
Pilot Testing Sample

Number of	Grade			
	4	8	10	12
Districts	13	13	3	9
Schools	33	24	6	12
Classes	60	60	6	30
Students	1453	1442	147	678
Test Forms	6	6	3	3

Because piloting took place only in the larger school districts, some geographic zones in the province were not represented in the sample. To ensure that questions were appropriate for those regions, copies of the pilot tests were sent to selected teachers in those areas, and they were asked to comment on the suitability of the items.

Teachers of all pilot test classes were asked for their opinions regarding the reading level of the items, the understandability of the format, the time allowance, and, for Grade 4, the desirability of including the attitude scale. As well, students were asked to comment on the appropriateness of the examples and items used.

The data from each pilot form were analyzed using the computer program LERTAP (Nelson, 1974). On the basis of the pilot results, items which showed any of the following characteristics were eliminated, or were examined in detail before

being considered for possible use on the final instruments:

- more than 95%, or fewer than 20%, of the students correctly answered the question (p-value greater than 0.95 or less than 0.20);
- the point-biserial correlation between correct response and the total test score was less than 0.20;
- the point-biserial correlation between any incorrect response and total test score was greater than 0.10;
- a distractor was selected by less than one percent of the respondents.

Change Categories and Items

One of the objectives of the 1981 Mathematics Assessment was to document change in student achievement since the 1977 Mathematics Assessment. In 1977, the Assessment focussed on three levels of cognitive behavior as the basis for reporting achievement. Three domains--Computation and Knowledge, Comprehension, and Applications--were used as major reporting units, each ranging across various content areas. In 1981, on the other hand, the basis for reporting consisted of a number of domains defined by content: Number and Operation, Geometry, Measurement, Algebraic Topics, and Computer Literacy. Hence, the problem of reporting change was compounded by two differing definitions of the term "domain". This lack of congruence forced the adoption of a new reporting unit for change, the Change Category. The number and content of Change Categories at each grade level were dependent upon how many 1977 items were suitable for use in 1981. Such items were selected according to a number of criteria:

- they had to suit the domains defined in 1981, since they were not to be set off in a separate group for change analysis only;
- they had to provide a good cross-section of the content defined for each Change Category;
- their 1977 p-values were to be less than 0.80 in order to allow for the possibility of growth in 1981, that is, to avoid possible ceiling effects.

A further consideration in developing the mechanism for reporting change was the number of items to be used in each Change Category. Because the measurement and reporting of change is a sensitive issue it was felt that there was a need to assign a considerable number of items to each Change Category. For Grades 4 and 8 this number was set at 12; for Grade 12 it was set at 10 since there were fewer items in

total to be used at this level. As a result, two or three categories were defined at each grade level. The categories are shown in Table 4-5, along with the number of items in each. These items were not pilot tested as sufficient information on their suitability was available from 1977.

Table 4-5
Change Categories

Grade 4	Grade 8	Grade 12
Number and Operation (12)	Number and Operation (15)	Number and Operation (10)
Measurement (11)*	Geometry and Measurement (12)	Geometry and Measurement (10)**
		Algebra (10)

*Only 11 items were available in this category.
**Reduced to 9 in the Assessment due to a printing error on the final instruments.

Construction of Test Forms

In contrast to 1977, the 1981 Assessment made use of several test forms per grade. By this means more items could be administered and a better understanding of achievement patterns could be obtained. At the same time, because each test form was given to a large sample--approximately 10 000 at each grade level--the results may be generalized to the provincial population with a high degree of confidence. This situation is different at the district level, where standard errors are large in some districts because of small enrolments.

All achievement items were multiple choice, with five options including an "I don't know" response. The forms, including background information and attitude items, as well as administration time, were to be completed in 45 minutes. Based on previous experience in assessment and test development, the number of achievement items per form was set at 46 for Grades 4 and 8, and 45 for Grade 12. To achieve adequate curriculum coverage and to measure change effectively, three forms, A, B, and C, were constructed for each of Grades 4 and 8, and two forms, A and B, for Grade 12. A key factor leading to these numbers was the requirement that district-level reporting be

based upon adequate numbers of students writing each form. For Grade 12, in particular, this was a serious problem as many school districts have small Grade 12 populations. Hence, only two forms were constructed at this level.

For the final selection of items, the Contract Team, bearing in mind the change items to be used, identified appropriate items from those surviving the pilot stage. For each objective a collection of items somewhat greater than the number required was presented to the Advisory Committee, and they made recommendations as to which items should be used. The final selection was made by the Contract Team after reviewing the face validity of each item and the adequacy of the group of items for testing each objective.

The first items to be assigned to final test forms were the change items. These were distributed in such a way as to avoid duplication of similar items on one form. In some cases, where items were related to an illustration, the items were retained as a group on the same form. The change items were positioned on the 1981 forms in locations similar to those they had occupied in 1977 in order to avoid any question of a fatigue factor in the event of changed performance.

Non-curricular items were deliberately not placed at the beginning of each form. Several easy items were selected to start each form and, following these, all remaining items were randomly assigned to forms within objectives. The final forms were generally balanced with equal numbers of items on each objective. A summary of item assignments is given in Table 4-6.

An informal timing pilot was conducted in December 1980 to ensure that the 45-minute time limit was still reasonable. The final forms were administered to six classes at each of Grades 4 and 8, and to four classes at Grade 12. Teachers were asked for information regarding the amount of time required and the clarity of the administration instructions. Results showed that the time allotted was sufficient. Some modifications were made to the directions for administration.

An indication of the equivalence of test forms within domains may be obtained by comparing means and standard deviations as shown in Table 4-7. These statistics were based on the results obtained by a 10% sample of students who wrote these items. Domain 5, Computer Literacy, has been excluded because only two items from that domain were included on each form.

Finally, because the school district is the smallest unit for reporting performance in the Assessment, it is important that district results be measured reliably. The reliability

Table 4-6
Structure of the 1981 Assessment Instruments

	Grade 4						Grade 8						Grade 12			
	A		B		C		A		B		C		A		B	
Objective	77*	81	77	81	77	81	77	81	77	81	77	81	77	81	77	81
1.1	3	9	3	9	3	9	2	4	2	4	2	4	2	1	1	2
1.2	1	2	0	3	0	3	2	4	2	4	2	4	2	3	2	3
1.3	0	4	1	3	1	3	1	3	1	3	1	3	1	2	2	1
2.1	0	3	0	3	0	3	1	1	1	1	1	1	1	2	1	2
2.2	0	4	0	4	0	4	1	3	1	3	1	3	1	2	2	1
2.3							0	2	0	2	0	2	0	3	0	3
3.1	2	4	2	4	2	4	1	2	1	2	1	2	1	2	1	2
3.2	2	2	2	2	1	3	1	3	1	3	1	3	2	1	2	1
4.1	0	3	0	3	0	3	0	6	0	6	0	6	3	4	4	3
4.2	0	2	0	2	0	2	0	2	0	2	0	2	2	1	1	2
4.3	0	3	0	3	0	3	0	2	0	2	0	2	0	3	0	3
4.4							0	3	0	3	0	3	0	3	0	3
5	0	2	0	2	0	2	0	2	0	2	0	2	0	3	0	3

*77 refers to items from the 1977 Assessment
81 refers to items used for the first time in 1981.

Table 4-7
Means and Standard Deviations of Domain Scores

Grade	Domain	Number of Items	Form A Mean	Form A S.D.*	Form B Mean	Form B S.D.	Form C Mean	Form C S.D.
	1	19	13.20	3.76	13.13	3.65	12.83	3.54
4	2	7	4.27	1.51	4.58	1.41	4.07	1.49
	3	10	5.62	1.99	5.79	2.03	6.10	2.13
	4	8	4.41	1.78	4.85	1.92	4.31	1.95
	1	16	10.05	3.44	10.16	3.24	9.76	3.51
8	2	8	4.55	1.74	4.59	1.77	4.55	1.70
	3	7	2.79	1.63	3.28	1.57	3.39	1.73
	4	13	6.55	2.94	6.59	2.48	6.81	2.56
	1	11	6.81	2.68	6.12	2.71		
12	2	9	5.26	1.84	5.71	1.96		
	3	6	3.35	1.90	3.47	1.64		
	4	16	8.45	3.77	8.66	3.45		

*S.D.-Standard Deviation.

figures shown in Table 4-8 are based upon school district mean domain scores.

Table 4-8
Reliability* of District Domain Scores

Domain	Grade 4	Grade 8	Grade 12
1	0.96	0.96	0.93
2	0.86	0.89	0.90
3	0.89	0.90	0.92
4	0.91	0.94	0.95
5	0.63	0.79	0.52

*coefficient α

4.4 Sampling

In 1 because of ever-increasing demands on the time of teach nd students in test-development and assessment activities e Ministry of Education adopted a policy which stipulated that, in a given school year, no school would be asked to participate in more than one assessment activity and one other testing activity sponsored by the Ministry of Education. For that reason schools selected for the pilot study, with the exception of the small timing pilot, were not included in the final Assessment. Schools previously selected for the IEA study were not used for the Assessment pilot study, but were eligible for inclusion in the Assessment proper.

A second decison taken by the Ministry of Education allowed assessment results for large districts to be based upon samples rather than upon the entire population at any grade level. Clearly, sampling was not feasible for all districts, given the large spread in student enrolments in the 75 school districts in the province. As a first step in constructing the sample a calculation was made for each district to determine the minimum sample size required to produce a 95% confidence interval of at most ±5% on each item. That is, in the "worst" case, for an item which 50% of the students sampled answered correctly, one should be "95% sure" that, if all the students in the district had responded to the item, between 45% and 55% of them would have obtained the correct answer to the item. On the basis of this calculation, school districts which were identified as being large enough to allow sampling in the Assessment were then used to provide classes for the pilot phase of the study.

At the Grade 4 level, 62 districts were too small to permit sampling, and all schools in those districts were included in the Assessment. In two other districts, only those schools participating in the pilot study were excluded. In each of the remaining eleven districts, eligible schools, that

is those which had not taken part in piloting, were ranked by Grade 4 enrolment. The number of schools to be omitted was determined on the basis of the minimum sample size required and the average school size in the district. The ordered list of schools was then divided into strata from each of which one school was to be eliminated. Those schools were selected randomly, using a table of random numbers. As a result, a further 161 schools in addition to the pilot schools were excluded. Although no rigorous analysis was undertaken, the sample of schools within each district appeared to be geographically representative of the district.

For Grades 8 and 12, after the pilot schools were excluded, it was impossible to exclude any other schools without distorting the representativeness of the Assessment results, because there are relatively few schools at those grade levels. Thus for Grade 8, Assessment results for 62 districts are based on all schools in the district; for 13 districts they are based on the schools remaining after the pilot schools were eliminated. For Grade 12 those numbers are 65 and 10, respectively.

The Grade 10 sample was designed to yield 2500 students. Within each of the six geographic zones of the province, schools were listed in order of enrolment in Grade 10. The sample size for each zone was determined in proportion to the zone enrolment. Within a zone, the list of schools was divided into strata of size such that two schools could be randomly drawn from each stratum. If a school happened to be drawn which did not also have Grade 8 or Grade 12 students to be assessed, that school was omitted and an alternative selected. The resulting sample consisted of 2525 students, 105 classes, 87 schools, and 45 districts.

The use of samples required that the enrolments in the participating schools be determined accurately. For all grade levels assessed, principals of participating schools were asked to indicate grade enrolments when returning completed instruments. These enrolment figures were compared to the information contained in the September 1980, Form I for each school. For Grade 12, the enrolment figures were adjusted for the normal drop-out rate to March 1981. If a large discrepancy existed between the principal's figure and the adjusted Form I estimate, the principal was contacted personally by B. C. Research in order to obtain the correct enrolment. For Grades 4 and 8, if the principal's figure was within 15% of the Form I estimate, it was accepted; otherwise, the Form I figure was used.

The use of samples also had to be taken into account in the reporting of results. In all cases where background information and attitude or achievement results are reported, the

figures have been weighted to reflect the characteristics of the sample. For example, if a p-value of 72% is reported for an achievement item, that figure is an estimate of the percent correct had all of the students in the province at that level responded to the item. The situation is similar in reporting background data. For example, where numbers of students responding to test forms are indicated, those numbers refer to the weighted totals taking sampling into account.

The provincial return rates for the Assessment instruments are shown in Table 4-9.

Table 4-9
Return Rates

	Grade			
	4	8	10*	12
Number of Eligible Students	30 150	34 579	2574	30 652
Return rate	95.6%	90.8%	95.4%	79.8%

*based on a design sample of 2500

4.5 References

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CHAPTER 5

GRADE 4 RESULTS

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This chapter contains a discussion of the Grade 4 results for each objective and domain assessed. A number of sample items from the Assessment instruments are presented and discussed as illustrative examples; however, because of space limitations, it was not possible to discuss each individual item in detail in this chapter.[1]

The Interpretation Panel at the Grade 4 level consisted of 14 members from across the province: 2 school principals, 7 teachers, a primary supervisor, a university professor, a school trustee, a parent, and a multi-cultural worker. It was their task to examine the province-wide results of the Assessment and to identify strengths and weaknesses in student achievement as measured by the tests. The Panel was asked to rate each item, objective, and domain result as

- Strong (ST)
- Very Satisfactory (VS)
- Satisfactory (S)
- Marginal (M)
- Weak (W)

These ratings are included in this chapter where applicable.

5.1 Description of the Instruments

The Grade 4 item pool contained 138 test items divided equally among three booklets, 46 per booklet. The items were designed to assess students' mastery of five domains: Number and Operation, Geometry, Measurement, Algebraic Topics, and Computer Literacy. The domains were subdivided into eleven objectives, as is shown in Table 5-1. The topics of Probability and Computer Literacy were included in the

[1]The Grade 4 Assessment booklets and item-results are reproduced in Appendix F.

Assessment at all levels even though they are not part of the prescribed curriculum. The results obtained on these two objectives may assist the Ministry and school districts in making decisions related to the revision of existing curricula for this level.

The number of items to be included in the item pool for each objective was decided on the basis of the relative importance of the objective for the grade level concerned. Thus, as is shown in Table 5-1, over 40% of the Grade 4 items fell into the Number and Operation domain. At the other extreme, the non-curricular topics, Probability and Computer Literacy, accounted for only 7% and 4% respectively.

Table 5-1
Grade 4: Organization of Test Items

Domain / Objective	Number of items	Percent
1. Number and Operation	57	41**
Number Concepts and Computation	36	26
Estimation	9	7
Fractions and Ratio	12	9
2. Geometry	21	15
Geometric Figures	9	7
Geometric Relationships	12	9
3. Measurement	30	22
Length, Area, Volume, and Mass	18	13
Time and Temperature	12	9
4. Algebraic Topics	24	17
Number Sentences	9	7
Graphs	6	4
Probability*	9	7
5. Computer Literacy*	6	4

*Non-curricular objectives.
**All percentages have been rounded to the nearest whole number.

The items in the Assessment are only a sample of all possible items for any given domain. The larger the sample, the more representative it is. So, for example, it would be more reliable to generalize results from Domain 1 which contained

57 items than from Domain 5 which contained only six items.

Items were selected to represent different levels of difficulty, and the Interpretation Panel was asked to take the difficulty of an item into account when rating the performance. That is, the more difficult the item, the lower the expected level of performance should be, and vice versa. Other factors the Panel was asked to consider were the importance of the skill represented by the item, the fact that some objectives were not part of the current curriculum, and the wide range of individual differences present at this level.

This proved to be an extremely difficult task as Item A/5 exemplifies. The question involves solving a missing addend equation. Knowing that 16% answered "I don't know", and that 25% knew that one had to subtract to obtain the solution, the 42% that answered correctly seems high. Yet, the Panel consensus rating on the result was Marginal.

A/5. To find the missing number in 746 + ___ = 931 you should:

	% of students
subtract 746 from 931	42†[2]
add 746 to 931	12
subtract 931 from 746	25
add 931 to 746	4
I don't know	16

Figure 5-1. Grade 4--Item A/5.

In addition to being categorized by content, the items were divided into one of three cognitive behavior levels: Computation and Knowledge, Comprehension, and Application. This dimension required that students use different types of skills and abilities in order to obtain solutions. Each item was placed in one domain, one objective, and one behavior level. A breakdown of the item pool is shown in Table 5-2.

[2]† indicates the correct answer.

Table 5-2
Grade 4: Number of Items by Cognitive Level and Domain

Domain	Knowledge	Comprehension	Application	Total
Number and Operation	25	13	19	57
Geometry	9	12	0	21
Measurement	11	13	6	30
Algebraic Topics	0	9	15	24
Computer Literacy	6	0	0	6
Total	51	47	40	138

All content items were multiple choice. Five choices were given for each item, the fifth one being "I don't know". Students responded to the test items in the test booklets by marking their choice of answer with an "x" in the appropriate box. The information from the booklets was then keypunched into machine-readable format.

In addition to the content items, each booklet contained nine background information items and an eight-item attitude scale which students were asked to complete before taking the test. Students were requested to answer the eight attitude items as honestly as possible after teachers had discussed an example with them.

Forty-five minutes were allotted for the Assessment. This included time for instruction, distribution and collection of the Assessment booklets, completion of the background and attitude items, and completion of the test items.

5.2 Description of the Population

The Mathematics Assessment at this level was designed for all students enrolled in Grade 4. Within sufficiently large districts, representative samples rather than the entire population participated. Also, schools which had taken part in the pilot-testing of the Assessment instruments were excluded from the testing which took place in the month of March. Of the schools that participated in the Assessment, principals reported the total number of eligible students to be 30 150. The Assessment instruments were actually written by 28 815 students, or 95.6% of the total. This compares favorably with the 1977 return rates.

Age, Sex, and Languages Spoken

The Assessment was administered during the month of March 1981. At that time, Grade 4 students who had been age 6 at the time of their enrollment in school should have been either 9 or 10 years old. Approximately 92% of students at the Grade 4 level fell into that category.

Approximately 1200 more boys than girls took part in the Assessment. About 52% of the respondents were boys while about 48% were girls.

Of the students enrolled in Grade 4, approximately 86% learned English as their first language. Ninety percent of the children at this level usually speak English at home.

Use of Calculators

A good deal of research interest in the field of Mathematics Education is currently focussed upon an examination of the effect of the use of calculators in the mathematics classroom. As part of the 1981 Assessment, students were asked several questions concerning their use of calculators. Their responses to these questions are summarized in Table 5-3.

Table 5-3
Grade 4: Use of Calculators

Category of Use	Percent
Use a calculator at home	39
Sometimes use a calculator to do homework	13
Sometimes use a calculator in school	4

The fact that only 4% of children in Grade 4 in 1981 have used a calculator in school may be indicative of the fact that educators are not convinced of the advisability of them with students at this level. But since almost ten times as many children use calculators at home as at school, the question of calculator use should be investigated. The uses of technological devices such as calculators, computers, video disks, and electronic games in the home and other out-of-school places should be anticipated. Programs should be planned that will

encourage the positive and educationally beneficial use of these devices.

Metric Usage

Each student's test booklet contained a list of four questions designed to assess the extent to which today's students "think metric". Each question was accompanied by two responses, both correct, and students were directed to choose the answer which came to mind first. The results obtained are displayed in Table 4-4.

Table 5-4
Responses to Metric Usage Items
(Percent)

	Grade 4	Grade 8	Grade 12
How much does a bicycle weigh?			
About 15 kilograms	40	26	16
About 35 pounds	59	72	82
What is the temperature in this room?			
About 20 degrees	61	38	40
About 70 degrees	38	60	59
How far is it from Prince George to Prince Rupert?			
About 700 kilometres	37	30	22
About 450 miles	63	67	77
How much gasoline can the gas tank in a large car hold?			
About 90 litres	41	22	19
About 20 gallons	59	74	79

The results show that students at all three levels tested do not "think metric". In only one case out of 12, the temperature item at Grade 4, did a majority select the metric response over the imperial. For each item the percent selecting the metric response was greatest in Grade 4 and lowest in Grade 12.

5.3 Attitudes toward Mathematics

At the Grade 4 level, eight items from the attitude scale entitled Mathematics and Myself were selected and the original wording was altered slightly to make it more suitable for use with children of that age. Each item had five response choices ranging from Strongly Disagree to Strongly Agree. Some of the items were stated positively: "I really want to do well in mathematics". Others were stated negatively: "If I had my choice I would not learn any more mathematics". The items covered a wide range of experiences that students might have had with mathematics.

The attitude scale appeared before the actual Assessment items in each booklet. Students were requested to read and answer by themselves the eight attitude items as honestly as possible after teachers demonstrated with an example on the blackboard.

Student responses show that, at Grade 4, most students felt positively toward mathematics. In fact, the summary scores for negative or strongly negative responses were less than 4% while the summary scores for positive or strongly positive responses were 78%. Table 5-5 shows the results for all attitude responses.

Table 5-5
Grade 4: Summary of Attitudes Toward Mathematics

Attitude	Percent of Students
Strongly Positive	35
Positive	43
Neutral	19
Negative	3
Strongly Negative	0

The results show that Grade 4 children generally have a very positive attitude toward mathematics. Ninety percent of the students at the Grade 4 level agreed with the statement "I really want to do well in mathematics". Eighty-six percent responded that they felt good about solving a mathematics problem by themselves. Seventy-eight percent of the students indicated that they would not choose to omit mathematics from their further schooling. Sixty-nine percent think mathematics is fun, 15% could not decide, and only 16% not think mathema-

tics was fun.

5.4 Domain 1: Number and Operation

This domain contained the largest number of items because of its importance in the curriculum. The 57 items were divided into three objectives: Number Concepts and Computation, Estimation, and Fractions and Ratio.

The mean percent correct for the 57 items in this domain was 70%. These results were rated as Very Satisfactory by the Interpretation Panel, the highest rating of the five domains. Considering the importance of this domain, it is encouraging that the students did so well. Table 5-6 displays the total number of items in each objective with the mean percent correct and the Interpretation Panel's rating.

Table 5-6
Grade 4: Number and Operation

Objective	Number of Items	Mean Percent Correct	Panel Rating
Number Concepts and Computation	36	74	VS
Estimation	9	62	S
Fractions and Ratio	12	62	VS

Number Concepts and Computation

Thirty-six items were used to measure students' mastery of this objective. The items dealt with the whole number concepts of place value and counting, mathematical principles, and the four basic operations with whole numbers. Considerable emphasis was placed on operations, particularly addition and subtraction, at all three cognitive levels. Problem-solving items included both single- and multi-step solutions.

The mean percent correct for this objective was 74%. Overall, the students' performance in this objective was rated as Very Satisfactory. Considering the large percentage of the curriculum that this objective covers, the results here are very pleasing. Table 5-7 shows a breakdown of the items by

Table 5-7
Interpretation Panel Ratings
Grade 4: Number Concepts and Computation

Rating	Number of Items
Strong	4
Very Satisfactory	16
Satisfactory	12
Marginal	2
Weak	2

rating category.

Items A/2[3] and C/2 are representative examples of items used to assess students' mastery of this objective. On Item A/2, 88% of students were able to name the place value of a given digit in a 4-digit number. This performance was rated Very Satisfactory by Panelists. On Item C/2, the performance was rated Strong as 88% of the students were able to perform column addition with regrouping correctly.

A/2. The 2 in 2645 means:

	% of students
2 hundreds	3
2 thousands	88†
2 ones	1
2 millions	5
I don't know	3

Figure 5-2. Grade 4--Item A/2

Students' performance on inverse operations and regrou-

[3]A/2 means item number 2 in booklet A.

C/2. ADD:

$$\begin{array}{r} 678 \\ 9 \\ +\ 34 \\ \hline \end{array}$$

	% of students
901	1
991	1
621	5
721	88†
I don't know	4

Figure 5-3. Grade 4--Item C/2.

ping was weaker than expected, and the Panel felt that these areas required more attention. An example of an item involving an inverse operation is B/4. Performance on this item, 49%, was rated as Weak by the Panel. Less than half of the students knew which two numbers to add to check a subtraction when all information was given. An example of a regrouping item is Item B/5 shown where only 52% of the students were able to regroup in a non-traditional manner. This result was rated as Marginal.

The Panel also found that students' ~~performance~~ was weaker on items that involved reading. In fact, for this objective the number of words per item actually distinguished the ten easiest items from the ten most difficult items. The average number of words per item on the ten items with the highest success rate was four, while the ten items with the lowest success rate had an average number of 18 words per item.

Students' overall performance in this objective was very good. Based on the results and the Panel ratings, it would appear that the content covered by this objective is being taught very well.

Estimation

Nine items were used to measure students' mastery of this objective. The items dealt with estimating the sum, difference, and product of whole numbers. Although it is generally agreed that the skill of estimation is important, it is a difficult one to test. There is no actual control over

B/4. To check this subtraction, which two numbers would be added?

```
  476
- 337
  139
```

	% of students
476 and 337	23
476 and 139	8
337 and 139	49†
337 and 476	5
I don't know	15

Figure 5-4. Grade 4--Item B/4.

B/5. Find the missing number:

3 tens + 12 ones = ___ tens + 2 ones

	% of students
4	52†
2	4
3	16
1	8
I don't know	20

Figure 5-5. Grade 4--Item B/5.

the methods children will use to answer an estimation item. For example, in Item A/20, students may do the subtraction first and then round off. Performance on this Item was rated Strong.

A/20. Mr. Fish had 567 hot dogs to sell at the ball game. He had 364 hot dogs left after the game. About how many did he sell?

	% of students
200	81†
600	2
500	2
300	8
I don't know	6

Figure 5-6. Grade 4--Item A/20.

The mean percent correct for the objective was 62%. Although the results for this objective as a whole were rated as Satisfactory, Panelists ageed they would like to see students do better in this area. Table 5-8 shows a breakdown of the items by rating category.

Table 5-8
Interpretation Panel Ratings
Grade 4: Estimation

Rating	Number of Items
Strong	2
Very Satisfactory	1
Satisfactory	2
Marginal	3
Weak	1

Students did well rounding off to the nearest 100, but not as well rounding off to the nearest 10. Performance on Item A/24 was rated Marginal because only 61% of the students correctly rounded 43 to the nearest 10.

The ability to round off numbers is an integral part of the skill of estimating. Because it is often more expedient to estimate than to actually compute, estimating skills, including rounding, should be taught and emphasized early in one's schooling.

A/24. Round off 43 to the nearest ten.

	% of students
30	7
50	8
40	61†
44	20
I don't know	5

Figure 5-7. Grade 4--Item A/24.

Fractions and Ratio

The 12 items in this objective were designed to comply with the current curriculum guide for mathematics which states that students should be able to identify unit fractions of objects and sets, and read and write equations using these fraction names by the end of Grade 3.

The mean percent correct for this objective was 62%. As a whole, performance in the objective was rated Very Satisfactory. Table 5-9 shows a breakdown of the items by rating category.

Table 5-9
Interpretation Panel Ratings
Grade 4: Fractions and Ratio

Rating	Number of Items
Strong	1
Very Satisfactory	5
Satisfactory	3
Marginal	2
Weak	1

It appears students are not as confident in identifying fractions as part of a set as they are in identifying fractions as part of a whole. Sixty-seven percent of the students recognized the figure that showed 1/4 shaded as part of a

whole in Item C/4. Yet 40% of the students mistakenly named as 1/3 the part of a set that was really 1/4 shaded in Item A/9. Only 10% could correctly identify a set that was 1/3 shaded in another item that involved recognition of equivalent fractions.

C/4. Which shows 1/4 shaded?

	% of students
	67†
	8
	7
	5
I don't know	10

Figure 5-8. Grade 4--Item C/4.

A/9. Which set is one-third (1/3) shaded?

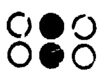
	% of students
	1
	10†
	40
	42
I don't know	6

Figure 5-9. Grade 4--Item A/9.

As there are several physical world models for both part-whole and subset-set interpretations of fractions, both should be taught. That is, children should be able to recognize that

1/3 of a chocolate bar and 1/3 of a dozen cookies both represent the fraction 1/3 but may be, in fact, different amounts.

Emphasis in the teaching of fractions usually is placed on considering fractions as parts of wholes. It may be the case that the idea of fractions as part of a set is too abstract to be taught at the primary level and should be postponed until later grades. Students at this level have had limited exposure to the subset-set concept of fractions and to the concept of ratio. Students' performance on the three ratio items were rated as Strong and Very Satisfactory; however, they were easy items.

5.5 Domain 2: Geometry

The geometry objectives in the current curriculum guide for Grade 3 deal mainly with the construction of geometric models and the manipulation of concrete materials. Because of the virtual impossibility of testing this, on a paper-and-pencil test the Assessment focussed on the concepts and knowledge needed to do those geometric constructions and manipulations. The 21 items were divided into two objectives: Geometric Figures and Geometric Relationships.

The mean percent correct for the twenty-one items in this domain was 62%. These results were rated as Satisfactory by the Interpretation Panel. Table 5-10 displays the total number of items in each objective with the mean percent correct and the Interpretation Panel's rating.

Table 5-10
Grade 4: Geometry

Objective	Total Number of Items	Mean Percent Correct	Panel Rating
Geometric Figures	9	75	VS
Geometric Relationships	12	52	S

Geometric Figures

Nine items were used to measure students' mastery of this objective. Students were asked to answer items concerning the identification of and distinguishing among geometric figures.

The mean percent correct for this objective was 75%. Overall, the students' performance in this objective was rated as Very Satisfactory. Table 5-11 shows a breakdown of the items by rating category.

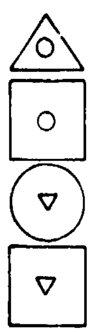
Table 5-11
Interpretation Panel Rating
Grade 4: Geometric Figures

Rating	Number of Items
Strong	1
Very Satisfactory	6
Satisfactory	2
Marginal	0
Weak	0

Panelists agreed that students at this level demonstrated good knowledge of the names of geometric figures. For example, in Item A/10, 86% of the students were able to identify the triangle inside the circle. This correct response percentage was rated Very Satisfactory.

A/10. Which is a picture of a
triangle inside a circle?

<u>% of students</u>



.... 12
.... 1
.... 86†
.... 1
I don't know 1

Figure 5-10. Grade 4--Item A/10.

Geometric Relationships

Twelve items were used to measure students' mastery of this objective. Students were asked to answer items concerning geometric relationships such as symmetry and congruence. The mean percent correct for items in this objective was 52%, and the students' performance was rated as Satisfactory. Table 5-12 shows a breakdown of the items by rating category.

Table 5-12
Interpretation Panel Ratings
Grade 4: Geometric Relationships

Rating	Number of Items
Strong	1
Very Satisfactory	4
Satisfactory	2
Marginal	3
Weak	2

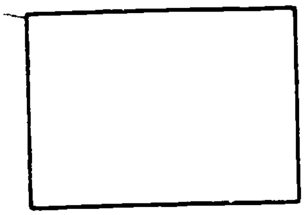
The Satisfactory interpretation for results on this objective was not so much an evaluation of students' responses but rather an evaluation of their efforts to answer something they had almost certainly not been taught. Although the term "symmetry" is mentioned explicitly in the curriculum guide, it was clear that the vast majority of students were unfamiliar with it. It also appears that the word "congruent" held no meaning for most students. Item C/27 is an example of an item where the term symmetry was used. Performance on this item was rated Marginal.

5.6 Domain 3: Measurement

The 30 items in this domain were divided into two objectives: Length, Area, Volume, and Mass; and Time and Temperature.

The mean percent correct for the 30 items in this domain was 60%. These results were rated as Marginal by the Interpretation Panel, the lowest rating of the five domains. Table 5-13 displays the total number of items in each objective with the mean percent correct and the Interpretation Panel's rating.

C/27. How many lines of symmetry does this shape have?



	% of students
1	1
2	14†
3	1
4	74
I don't know	10

Figure 5-11. Grade 4--Item C/27.

Table 5-13
Grade 4: Measurement

Objective	Total Number of Items	Mean Percent Corrent	Panel Rating
Length, Area, Volume, and Mass	18	58	M
Time and Temperature	12	63	M

Length, Area, Volume, and Mass

Eighteen items were used to measure students' mastery of this objective. They dealt with the measurement of length, perimeter, area, volume, capacity, and mass of a physical object in metric units. Also included were items involving conversion of units within the metric system.

The mean percent correct for this objective was 58%, and this performance was rated as Marginal. Table 5-14 shows a breakdown of the items by rating category.

Although students were able to choose correct measurement units, they were not as confident in making applications using measurement. For example, in Item C/29, only 12% of the students could correctly answer a perimeter question without being given a diagram. This result was given a Weak rating.

Table 5-14
Interpretation Panel Rating
Grade 4: Length, Area, Volume, and Mass

Rating	Number of Items
Strong	3
Very Satisfactory	2
Satisfactory	5
Marginal	5
Weak	3

C/29. Mr. Jones put a wire fence all the way around his rectangular garden. The garden is 10 m long and 6 m wide. How many metres of fencing did he use?

	% of students
16 m	60
32 m	12†
36 m	4
60 m	17
I don't know	8

Figure 5-12. Grade 4--Item C/29.

On a related item including a diagram, 60% obtained the correct answer. This result was considered Satisfactory.

Performance on items involving the conversion of length units was disappointing. Only 67% of the students could equate 100 centimetres with one metre. That result was rated only Marginal. Considering the fact that these students should have been taught the metric system and only the metric system since they entered school, the results in this domain are somewhat disappointing.

Performance on items dealing with area, mass, and volume was rated Marginal to Satisfactory. Even though these are abstract concepts, the Panelists felt that students should be more familiar with them.

Results were also inconsistent. Item A/39 showed a lack of familiarity with units of mass, and this result was rated Weak. On the other hand, results of Item C/38, rated Very Satisfactory, imply that students are very confident with units of capacity. One possible reason for this inconsistency

A/39. A ten-year-old boy is likely to weigh:

	% of students
35 grams	7
75 grams	18
35 kilograms	20†
75 kilograms	40
I don't know	14

Figure 5-13. Grade 4--Item A/39.

C/38. A milk jug is likely to hold:

	% of students
1 millilitre	5
10 millilitres	6
1 litre	83†
100 litres	4
I don't know	3

Figure 5-14. Grade 4--Item C/38.

is that children actually see units of capacity more often than units of mass. For example, all milk cartons are labelled in metric units.

Time and Temperature

Twelve items were used to measure students' mastery of this objective. Students were asked to respond to items dealing with topics such as reading a clock to the nearest five-minute interval, recording time using the conventional notation, recognizing time relationships from seconds to years, and reading a Celsius thermometer.

The mean percent correct for this objective was 63%, a performance which was rated as Marginal. Table 5-15 shows a breakdown of the items by rating category.

Table 5-15
Interpretation Panel Ratings
Grade 4: Time and Temperature

Rating	Number of Items
Strong	1
Very Satisfactory	3
Satisfactory	1
Marginal	6
Weak	1

Students were able to read clocks and thermometers; however, they are apparently unable to use standard notation for time. Ninety percent of students, a Strong result, read the clock on one item to obtain the correct time. but only 69%, a Marginal result, could choose the proper notation for half past two in Item C/18.

Students were able to read thermometers directly but were poor at selecting appropriate temperatures for given weather conditions. As in the case of the item discussed earlier dealing with mass, this may indicate a general lack of familiarity with metric units. Results of Item A/44, rated Weak, illustrate this weakness. The most frequent response was the Fahrenheit temperature.

C/18. Which says half past two?

	% of students
30:2	13
230	7
2:30	69†
2.30	7
I don't know	4

Figure 5-15. Grade 4--Item C/18.

A/41. The temperature on a sunny summer day would most likely be:

	% of students
5° Celsius	1
25° Celsius	26†
55° Celsius	27
85° Celsius	34
I don't know	10

Figure 5-16. Grade 4--Item A/41.

5.7 Domain 4: Algebraic Topics

The 24 items in this domain were divided among three objectives: Number Sentences, Graphs, and Probability.

The mean percent correct for the 24 items was 58%. These results were rated as Satisfactory by the Interpretation Panel.

Results on all three objectives tended to be Satisfactory. In the case of Number Sentences and Graphs, the Panel felt that students did not do as well as they should have; however, for the Probability objective, ratings tended to be Satisfactory because the topic is not part of the prescribed curriculum. Table 5-16 displays the total number of items in each objective with the mean percent correct and the Interpretation Panel's rating.

Table 5-16
Grade 4: Algebraic Topics

Objective	Total Number of Items	Mean Percent Correct	Panel Rating
Number Sentences	9	55	M to S
Graphs	6	68	S
Probability	9	55	S

Number Sentences

Nine items were used to measure students' mastery of this objective. Items dealt with definitions and symbols in algebra, the use of variables in equations and inequalities, and the use of variables to represent numbers.

The mean percent correct for this objective was 55%, and this performance was rated as being between Marginal and Satisfactory. Table 5-17 shows a breakdown of the items by rating category.

Table 5-17
Interpretation Panel Rating
Grade 4: Number Sentences

Rating	Number of Items
Strong	0
Very Satisfactory	2
Satisfactory	2
Marginal	4
Weak	1

Students' ability to recognize the number sentences to be used in setting up problems was rated as Satisfactory. On two word problems, 67% and 71% chose the appropriate number sentence to solve the problem. It is important to bear in mind that developing the students' ability to apply the appropriate mathematical techniques in order to solve a given problem is one of the most important reasons for teaching and learning mathematics. There is no point in teaching children how to add, subtract, multiply, and divide numbers unless they also learn when to apply these operations. The results reported here indicate that a fairly substantial degree of progress toward that goal has been attained at the Grade 4 level insofar as problem solving is concerned.

Solving missing addend questions appears to be an extremely difficult task for students at this level. Results of Item A/5, rated Marginal, show that only 42% of the students could correctly solve a 3-digit missing addend question.

A/5. To find the missing number in 746 + ___ = 931 you should:

	% of students
subtract 746 from 931	42†
add 746 to 931	12
subtract 931 from 746	25
add 931 to 746	4
I don't know	16

Figure 5-17. Grade 4--Item A/5.

Considering results from other sections of the Assessment, the difficulty does not appear to lie with the actual computation but with the concept of inverse operation itself.

According to the Interpretation Panel, results on items dealing with the knowledge and use of inequality symbols ranged from Weak to Very Satisfactory. Results on Item B/12, rated Marginal, seem to indicate that students are not familiar with the symbol ">"; however, results of Item B/29, rated Very Satisfactory, indicate that they are. Many Panelists felt students did not recognize the form of the question in

B/12. Choose the missing number.
207 > ___ > 198

	% of students
188	14
203	29†
209	14
197	15
I don't know	28

Figure 5-18. Grade 4--Item B/12.

B/29. Choose the correct symbol to make this a true sentence.

13 ___ 6

	% of students
>	77†
=	2
<	13
≤	1
I don't know	7

Figure 5-19. Grade 4--Item B/29.

Item B/12.

The question of whether or not inequality symbols are useful at this level or not needs to be considered. The members of the Interpretation Panel agreed the symbols were difficult to learn, but suggested that if the meaning were stressed more, they would be valuable concepts to know at this level.

Graphs

Six items were used to measure students' mastery of this objective. The items involved the reading and interpretation of bar graphs, line graphs, and pictographs. The mean percent correct for this objective was 68%, and this performance was rated as Satisfactory by the Interpretation Panel. Table 5-18 shows a breakdown of the items by rating category.

Table 5-18
Interpretation Panel Ratings
Grade 4: Graphs

Rating	Number of Items
Strong	1
Very Satisfactory	1
Satisfactory	4
Marginal	0
Weak	0

Students generally did well in graphing and the Satisfactory rating of their performance on this objective may be somewhat low. The Panel felt, however, that graphing is an area in which students should do well. They felt that a lot of work is done across subject areas in the primary grades in graphing. For that reason, results might be expected to be even higher. The two items receiving the highest success rates required students merely to read graphs. On those items requiring more than simple reading of graphs, the results were only Satisfactory.

Probability

Probability was one of the two non-curricular objectives included as part of the Assessment. The main purpose for the inclusion of probability was to provide base-line information on a topic which many people feel is important and should be part of the curriculum. Results on this objective may assist the Ministry and school districts in decisions related to the revision of existing curricula for this level.

Nine items were used to measure students' ability to judge the outcomes of situations involving basic concepts of probability. The mean percent correct for this objective was 55%. Performance was rated as Satisfactory even though the topic is not prescribed and many children have had no previous

exposure to these types of questions. Table 5-19 shows a breakdown of the items by rating category.

Table 5-19
Interpretation Panel Ratings
Grade 4: Probability

Rating	Number of Items
Strong	0
Very Satisfactory	3
Satisfactory	5
Marginal	1
Weak	0

Of the nine probability items, the three with highest results were accompanied by illustrations and were related to day-to-day experiences of children. For example, it may have helped children answer Item B/8 if they had been familiar with spinners. The fact that 56% of students answered the item correctly was rated Satisfactory by the Interpretation Panel.

B/8. Sam and Sara are playing a game with this spinner. Every time the spinner lands on red, Sara gets a point. Every time the spinner lands on blue, Sam gets a point. After 10 spins, the winner will be the one with the most points. Who is more likely to win?

	% of students
Sara will	8
Sam will	56†
It will be a tie	9
Either one has the same chance of winning ...	24
I don't know	4

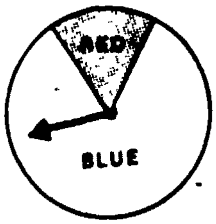


Figure 5-20. Grade 4--Item B/8.

5.8 Domain 5: Computer Literacy

Computer Literacy was the second of two non-curricular objectives included in the Grade 4 Assessment. As with Probability, the main purpose for its inclusion was to provide base-line information on a topic which many people feel is important and should be part of the curriculum. Results on this objective may assist the Ministry and school districts in decisions related to the revision of existing curricula for this level.

Six items were used to measure students' mastery of this objective. Students were asked to answer items concerning the capabilities and applications of contemporary computers and to make judgments regarding the social impact of contemporary computers. Questions dealt with what computers could do, not with programming, flow charting, and so on.

The mean percent correct for this objective was 41%, a level of performance that was rated as Satisfactory. Table 5-20 shows a breakdown of the items by rating category.

Table 5-20
Interpretation Panel Ratings
Grade 4: Computer Literacy

Rating	Number of Items
Strong	0
Very Satisfactory	1
Satisfactory	5
Marginal	0
Weak	0

The Panel tried to keep in mind, when rating the items, that these were difficult questions for children who had not had any exposure to computer literacy before. The percent of correct responses ranged from 22% to 66%.

Panelists agreed that, with the increasing use of computers and calculators in society, the school must play a role in the teaching of computer literacy. The form and extent it should take in the mathematics curriculum, and in the primary mathematics curriculum in particular, was considered. At the primary level, exposure to terminology, uses, and functions of computers at a very basic level is needed, but without empha-

sis on technical aspects. The practicality of even such a limited goal as exposure to computer literacy has its difficulties. Many schools still do not have access to calculators and computers, especially at the primary level, useful curriculum materials are not readily available, and many mathematics teachers do not feel confident or competent in teaching computer literacy. Panelists generally felt that, although Computer Literacy is becoming increasingly important, it is not a priority topic at the Primary level.

5.9 Changes in Achievement Since 1977

The Change Categories consisted of items that had appeared on the 1977 Mathematics Assessment and were repeated on the 1981 Assessment in order to obtain information on the nature and extent of change. Twelve items from the 1977 test were included in the Number and Operation Change Category. Another eleven were chosen for the Measurement Change Category.

Results of the two Change Categories studied in Grade 4 show that the standard of performance in mathematics for students at this level is being maintained. In comparison to results in 1977, students performed better on more than 50% of the change items.

Number and Operation

Of the fifty-seven items in the Number and Operation Domain, twelve were included in the Change Category. The mean percent correct for these twelve items was 72% in both 1977 and 1981. The performance change on most items was less than 6%.

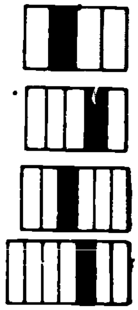
The largest increase, 16%, was found on Item ^/26, a fraction item, where the results went from 54% in 1977 to 70% in 1981. Although many factors may have contributed to this increase, it may be that a greater emphasis has been placed on the teaching of unit fractions since 1977, at least in part-whole situations.

Measurement

Of the thirty items in the Measurement Domain, eleven were included in the Change Category. The mean percent correct for these eleven items was 60% in both 1977 and 1981, and the performance change was minimal on most items.

The largest increase, 14%, was found on a metric usage item involving capacity, where the results went from 69% in

C/26. Which box is one-fifth (1/5) shaded?



	% of students
Box 1	6
Box 2	70†
Box 3	8
Box 4	11
I don't know	5

Figure 5-21. Grade 4--Item C/26.

1977 to 83% in 1981.

5.10 Reporting Categories

A student's achievement in Mathematics is the result of the interaction of a large number of factors, some intrinsic and others extrinsic to the student. Age, sex, and other attributes inherent in the student combine with curriculum variables and environmental variables, such as teacher differences, to influence overall student performance. A great deal of information concerning the relationship between student background variables and achievement was collected in this Assessment, far more than can be fully discussed in a report of this length. From the large number of variables believed to be related to achievement, a smaller set of variables was selected and the relationship of these factors to performance was studied.

In the sections that follow, all of the results reported are based on correlational trends. No attempt has been made to imply that cause-and-effect relationships exist since the Mathematics Assessment was not designed to identify such relationships. All that can be said is that, on the basis of the Assessment data, there appears to be a relationship between certain variables. It remains for other studies designed as follow-ups to seek causal relationships.

Sex Differences

Based on the items used in the Assessment, results showed that at the Grade 4 level boys obtained a higher mean percent correct on three of the five domains assessed. Some of the differences were statistically significant, but quite small; the largest difference was 3%. Boys did somewhat better than girls in Algebraic Topics and Computer Literacy. Boys performed better than girls in the Measurement domain. On both objectives the mean percent correct for boys was about three points higher than for girls. Figure 5-22 portrays the results for each domain by sex.

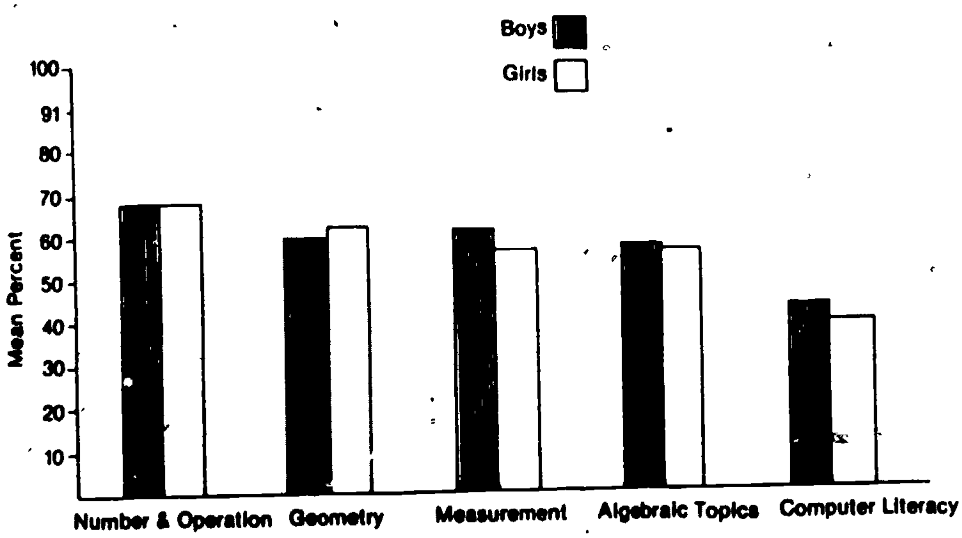


Figure 5-22. Grade 4--Sex differences in achievement.

Girls performed better than boys in the Geometry domain. It is worth remembering that the Geometry items largely concerned vocabulary as opposed to spatial visualization and concrete experience. Girls also performed somewhat better than boys in the Number and Operation Domain.

First Language

In one of the background items in the Assessment booklets, students were asked whether English was their first language. The results of analyzing the achievement data on each domain for two subgroups, those who responded YES to the question and those who responded NO, favor those students who first learned to speak English. The differences on domain scores were small with the greatest difference occurring in

the Geometry domain, specifically in the Geometric Relationships objective.

Attitude

The attitude of Grade 4 students toward Mathematics and their achievement by domain were correlated. It was found that a positive attitude toward Mathematics is moderately correlated with achievement in all Domains except Computer Literacy.

Girls' attitudes toward Mathematics are slightly more positive than boys' in Grade 4. In Grade 8, however, boys' attitudes are slightly more positive than girls'. The trend of deteriorating attitudes among girls in comparison to boys is continued through Grade 12.

This finding is not surprising. It seems reasonable that a correlation between attitude and achievement should exist. The fact that the correlation between attitude and achievement in Computer Literacy is weak may be due to the fact that the items in this domain are not necessarily mathematical content, but, for many students, general knowledge.

5.11 Summary

The Grade 4 item pool contained 138 test items designed to assess students' mastery of eleven objectives grouped into five domains. Two of these objectives were not prescribed in the current Primary Mathematics Curriculum. The number of items to be included in the item pool for each objective was divided on the basis of the relative importance of the objective for Grade 4. Items represented different levels of difficulty and were also classified under one of three cognitive behavior levels. Each item was categorized in one domain, one objective, and one behavior level.

Twenty-three items were repeated from the 1977 Assessment in order to obtain information on the nature and extent of change. These items formed two Change Categories.

In addition to the content items, each booklet contained nine background information items and a eight-item attitude scale which students were asked to complete before taking the test.

Background Information

The Grade 4 Mathematics Assessment was designed for all students enrolled in Grade 4. Of the schools that ırticipated in the Assessment, principals reported the tota' number of eligible students to be 30 150. The Assessment in. rument was written by 28 815 students, or 95.6% of the to+ About 52% of the respondents were boys while abc 48% were girls. Ninety-two percent of the Grade 4 students were either nine or ten years old when the Assessment instrument was administered in March 1981. Approximately 86% of the students enrolled in Grade 4 learned English as their first language, and 89% usually speak English at home. The data gathered on the use of calculators show that almost 40% of the students use a calculator at home, about 13% sometimes use a calculator to do homework, and only 4% sometimes use a calculator in school.

Test Results

The 138 test items were divided among five domains: Number and Operation, Geometry, Measurement, Algebraic Topics, and Computer Literacy. Each domain was subdivided into a number of objectives, and the items were generated to measure mastery of the objectives.

The Number and Operation domain was divided into three objectives: Number Concepts and Computation, Estimation, and Fractions and Ratio. Students' performance in this domain was generally Very Satisfactory. Panelists were very pleased with these results considering the importance of this domain. Place value, computation, and fraction questions were well done. Weaker areas included questions involving inverse operations, regrouping, and rounding. Students' performance was markedly weaker on items that required more reading.

The Geometry domain was divided into two objectives, Geometric Figures and Geometric Relationships. Students demonstrated good knowledge of the names of geometric figures. Some more difficult questions involved abstract visualizations, and students performed satisfactorily on these. Many students were unfamiliar with the content of items in the Geometric Relationships objective. In particular, the term "symmetry" held no meaning for most students. Despite this, students' performance was rated as Satisfactory on this objective.

The Measurement domain consisted of two objectives: Length, Area, Volume, and Mass; and Time and Temperature. Of all the domains, Measurement had the most disappointing results. Despite the emphasis placed in recent years on learning the metric system and despite the fact that it is the only system of measurement these students have been taught, they are still unfamiliar with many of the metric units. Knowledge

of units of mass in particular seemed to be weak. A strength was shown with units of capacity, and students were able to read clocks and thermometers. On the other hand, they displayed some difficulty with standard notation for time and for selecting temperatures for given weather conditions.

The Algebraic Topics domain consisted of three objectives: Number Sentences, Graphs, and Probability. Students' performance on the Number Sentences objective was rated Marginal to Satisfactory. Solving missing addend and inverse operation questions appeared to be an extremely difficult task for students at this level. Another particular weakness was shown in the knowledge and use of inequality symbols. Recognition of number sentences to be used in problem solving was Satisfactory to Very Satisfactory. Students performed well on graphing items. Of the six questions, four were rated Satisfactory, one Very Satisfactory, and one Strong. Probability was one of the two non-curricular objectives, and performance on this objective was rated Satisfactory considering the topic is not prescribed and many children have had no previous exposure to these types of questions.

The Computer Literacy domain was the second of two non-curricular objectives included in the Assessment. The items in this objective dealt with what computers could do, not with programming, and flow-charting. The performance in this objective was rated Satisfactory in view of the fact that it is not a prescribed topic.

Sex Differences

Based on the items used in the Assessment, results show that at the Grade 4 level, boys performed better on three of the five domains assessed. The three domains were Measurement, Algebraic Topics, and Computer Literacy. Girls outperformed boys on the other two domains. All differences were slight.

Language

Students were asked to respond YES or NO to the question "Was English the language you first learned to speak?". The two resulting subgroups were correlated with achievement data on each domain. All results slightly favored the students who had first learned to speak English.

Attitude

A positive attitude toward Mathematics is moderately correlated with achievement in all Domains except Computer Literacy. The correlation between attitude and achievement in Computer Literacy may be weak because the items in this domain were not necessarily mathematical content.

Based on the sample drawn from the Assessment data, it was found that girls' attitudes are slightly more positive than boys' at Grade 4.

CHAPTER 6

GRADE 8 RESULTS

Leslie H. Dukowski and Thomas O'Shea

The results of the Assessment for Grade 8 are summarized in this chapter. A discussion of the results by domain and objective is preceded by descriptions of the instruments, of the student population, and of their attitudes toward mathematics. Reporting categories, changes in achievement since the 1977 Assessment, and an overall summary follow the discussion of the test results. Specific items have been used to illustrate Assessment objectives but, because of space limitations, it was not possible to discuss every item.[1] All percentages reported in the chapter have been rounded to the nearest whole number.

The Grade 8 Interpretation Panel rated the results obtained on each item, objective, and domain using five rating categories:

- Strong (ST)
- Very Satisfactory (VS)
- Satisfactory (S)
- Marginal (M)
- Weak (W)

The ratings given by the Panel were based on their personal and professional opinions of the acceptability of the results, and should not be considered as absolute. The ratings and pertinent comments of the Panel for each domain and objective are given in the chapter.

Since this was the second Provincial Learning Assessment in Mathematics for B. C., data from the first Assessment have served as a benchmark to which student performance in 1981 was compared. Twenty-seven items from the 1977 Assessment were repeated on the 1981 instruments. These items, grouped into two Change Categories, were used to measure changes in student performance during the four year interval between Assessments.

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[1]The Grade 8 test booklets and individual item results are reproduced in Appendix G.

6.1 Description of the Instruments

Three test booklets, A, B, and C, each containing 46 achievement item were used at the Grade 8 level. The pool of 138 items tested 13 objectives in five domains: Number and Operation, Geometry, Measurement, Algebraic Topics, and Computer Literacy. Each test booklet also contained a common set of twelve items dealing with student background information and a 19-item scale designed to measure students' attitudes toward mathematics. All items were multiple-choice and students marked their answers directly in the test booklets.

The student background items provided information on students' age, gender, first language, school attendance history, use of calculators and computers, homework, and familiarity with SI metric units. The attitude scale, Mathematics and Myself, contained 19 five-point Likert-scale items.

The achievement items each had five response choices. Four of these were possible answers, while the fifth option for each item was "I don't know". Each test booklet contained an equal number of items for each of the 13 objectives, and no achievement item appeared in more than one test booklet. Table 6-1 shows the distribution of items by domain, objective, and cognitive level.

Table 6-1
Distribution of Items

Domain	Knowledge	Comprehension	Application	Total
Number and Operation	21	9	18	48
Geometry	7	9	8	24
Measurement	14	1	6	21
Algebraic Topics	10	16	13	39
Computer Literacy	6	0	0	6
Total	58	35	45	138

Of the objectives tested, four deal with content which is outside the curriculum presently prescribed in B. C. These objectives are Logical Reasoning, Probability, Statistics, and

Computer Literacy.[2] Inclusion of this content in the mathematics curriculum has been recommended by groups such as the National Council of Teachers of Mathematics and the National Council of Supervisors of Mathematics. Information regarding students' knowledge about some of the most basic ideas of these topics will be useful in any future review or revision of the Mathematics curriculum in this province. The other nine objectives cover content normally taught up to and including Grade 7.

About 400 test items were developed over the summer of 1980 and were drawn from a number of sources. Some were chosen from those made public by the National Assessment of Educational Progress in the U. S., others from the British Columbia Mathematics Test Project and the Minnesota Educational Computing Consortium computer literacy questionnaire. Many were written specifically for the 1981 Assessment (Klassen, Dukowski, and deGroot, 1980). Some items, designated as change items, were repeated from the 1977 Assessment.

The items underwent a thorough piloting and review process in the Fall of 1980 and, eventually, 138 of them with good psychometric characteristics and a close fit with the stated objectives were chosen for the final forms of the test instruments. These items were distributed among the three test forms, and subsequent pilot testing verified that the total administration time of the instruments, including student background and attitude sections, would not exceed forty-five minutes.

6.2 Description of the Population

A total of 31 390 Grade 8 students wrote the 1981 Mathematics Assessment test booklets: 10 577 wrote booklet A; 10 447, booklet B; and 10 366, booklet C.

Age, Sex, and First Language

The data gathered from the background items indicate that most Grade 8 students, 91% of them, are between 13 and 14 years old. This age range is the one which should contain most students who enrolled in Grade 1 at age six. Seven percent of the students were older than 14 years and 2% were younger than 13. Approximately 400 more males than females participated in

[2] The Computer Literacy domain was not subdivided into objectives.

the Assessment. Responses to the items regarding language reveal that while 13% of the students did not learn English as a first language, only 7% usually speak some language other than English at home.

Calculators and Computers

A great deal of research and discussion has taken place regarding the use of hand-held calculators in the mathematics classroom. In this Assessment students were asked several questions concerning calculator use. Although the items were not identical to those asked in 1977, they were very similar, so the responses to these questions for both 1977 and 1981 are given in Table 6-2.

Table 6-2
Grade 8: Use of Hand-Held Calculators 1977-1981
(Percent)

Category of Use	1977	1981
Have used a calculator at home	35	36
Have used a calculator for homework	29	34
Have used calculator at school	10	15

Calculator use has not increased dramatically as some educators may have expected. This may be due in part to the "back-to-basics" movement which was prevalent in the period between the two Assessments. Other factors may be that educators are not convinced of the advisability of using calculators at this level, or that they are reluctant to use calculators unless class sets of them are available. One further reason may be that the Ministry of Education has not sanctioned calculator use in the intermediate and junior secondary grades as it has in the senior secondary grades by allowing their use on scholarship examinations.

Regarding the presence of computers in schools, almost half the students indicated that there was a computer in their school. Surprisingly, almost 25% of the students did not know if there was a computer in their school or not. Table 6-3 summarizes the data for Grades 8 and 12. The data were not gathered at Grade 4.

Table 6-3
Computers in Schools (Percent)

Response	Grade 8	Grade 12
YES	49	67
NO	26	14
I don't know	24	18

The responses to items which ask how and where computers are used in schools show that, at Grade 8, computers are used mainly in mathematics classes and are are usually used in teacher demonstrations. In Grade 12 there is a greater use in other disciplines and student use increases.

Homework Assignments

Students were asked how long it had taken them to complete their last homework assignment in mathematics. The data in Table 6-4 show that about 73% of the students have homework

Table 6-4
Grade 8: Homework Assignments

Length of Last Homework Assignment	Percent
There have been no homework assignments	8
Between 1 and 10 minutes	23
Between 11 and 30 minutes	50
Between 31 and 60 minutes	11
More than one hour	4
No response	4

assignments which take at most 30 minutes to complete. In 1977 one half of the students estimated that their homework averaged less than 30 minutes per day and one quarter estimated they required between 30 and 60 minutes per day. In 1977 about 15% of the students said that they spent no time at all on mathematics homework, whereas in 1981 only about 8% indicated that they had no homework assigned.

Metric Usage

The present curriculum guide for mathematics in B. C. contains the following statement on metrication.

The Federal Government has committed Canada to

> the change to the Metric system. This change will take place over a ten year period and is tc be completed by 1981. Commencing in September, 1973, all primary pupils began to use the metric system as a standard of measurement. It has been agreed by the council of Ministers of Education, Canada, that all instruction in elementary and secondary schools will be predominently (sic) metric by 1978. Mathematics for years K-12 will be completely metric by that date. (page 3)

The information provided by the metric usage items shows that this statement has not proved true. Students clearly do not "think metric". Each of the metric usage items consisted of a question followed by two statements. Both statements, one in SI metric units and the other in British units, were correct answers to the question. Students were told that both answers were correct and were asked to respond by selecting the answer which came to mind first. For example, one question asked "How much does a bicycle weigh?". This question was followed by the statements "About 15 kilograms" and "About 35 pounds". Three quarters of the students chose the latter statement. This pattern was typical for all four items. Grade 4 students tended to use metric units more than the Grade 8 students and Grade 12 students tended to use them less. The results are summarized in Table 6-5.

Table 5-5
Responses to Metric Usage Items
(Percent)

	Grade 4	Grade 8	Grade 12
How much does a bicycle weigh?			
About 15 kilograms	40	26	16
About 35 pounds	59	72	82
What is the temperature in this room?			
About 20 degrees	61	38	40
About 70 degrees	38	60	59
How far is it from Prince George to Prince Rupert?			
About 700 kilometres	37	30	22
About 450 miles	63	67	77
How much gasoline can the gas tank in a large car hold?			
About 90 litres	41	22	19
About 20 gallons	59	74	79

6.3 Students' Attitudes toward Mathematics

Each Grade 8 and Grade 12 test booklet contained a 19-item scale designed to assess students' attitudes toward mathematics. The scale, Mathematics and Myself, was developed for use in the Second International Study of Mathematics, and many of the items were also used in the 1978 study of mathematics achievement conducted by NAEP in the U. S. At the Grade 4 level, only eight of the items were used.

Each item had five response choices ranging from Strongly Disagree to Strongly Agree. Some of the items were stated positively: "I really want to do well in mathematics." Others were stated negatively: "No matter how hard I try I still do not do well in mathematics." The statements covered a wide range of experiences that students might have had with mathematics.

Results show that, at Grade 8, most students feel positively toward Mathematics. In fact, only 6% of the responses were negative or strongly negative, while 60% of the responses were positive or strongly positive.

There are some interesting individual item results at Grade 8. Ninety-three percent of the students agreed with the statement "I really want to do well in mathematics" and over 95% indicated that their parents wanted them to do well in mathematics. Eighty-three percent responded that they felt good about solving a mathematics problem by themselves. With regard to taking more mathematics, 78% said that they were not afraid of mathematics and 56% said that they were looking forward to taking more mathematics. Seventy-three percent of the students indicated that they would not choose to omit mathematics from their schooling.

6.4 Domain 1: Number and Operation

By the end of Grade 7, students are expected to be able to perform the four basic operations of addition, subtraction, multiplication, and division with whole numbers, common fractions, and decimal fractions. Students at this level are also expected to have some understanding of number concepts, to be able to perform calculations involving ratio, proportion, and percent, and to be able to apply their computational skill to solve word problems. The items in the Number and Operation domain were intended to measure those skills and understandings. The set of items had a wide range of difficulty. The results of the items in each objective of this domain are presented in Table 6-6; the Interpretation Panel ratings are also

Table 6-6
Grade 8: Number and Operation

Objective	Number of Items	Mean Percent Correct	Panel Rating
Whole Numbers	18	69	S
Fractions and Decimals	18	59	M
Ratio, Proportion, and Percent	12	61	M
Total	48	63	M

included.

There were 16 items in each booklet from the Number and Operation domain covering three objectives: Whole Numbers; Computation with Fractions and Decimals; and Ratio, Proportion, and Percent. Fifteen of the total of 48 items in this domain were change items.

The Interpretation Panel rated the results of each of the items in the domain and also assigned a rating to each objective and to the domain as a whole. The overall rating for the Number and Operation domain was Marginal. The ratings for each objective are discussed below.

Whole Numbers

The overall rating by the Interpretation Panel for the students' performance on the 18 items in this objective was Satisfactory, and Table 6-7 contains a summary of the ratings given. The ratings indicate that students' skill with whole number computation is Satisfactory to Very Satisfactory with only one result on a division question rated as Marginal. That item, E/3,[3] was correctly answered by 72% of the students and is reproduced in Figure 6-1.

Table 6-7
Interpretation Panel Ratings
Grade 8: Whole Numbers

Rating	Number of Items
Strong	0
Very Satisfactory	6
Satisfactory	5
Marginal	6
Weak	1

B/3. Divide: 9315 ÷ 23 =

	% of students
405 remainder 0	72†*
45 remainder 0	12
450 remainder 3	5
315 remainder 3	4
I don't know	6

Figure 6-1. Grade 8--Item B/3.

The results which received the lowest ratings were generally on word problems or on those items which involved place value concepts and operations with zero. Members of the Interpretation Panel suggested that the low scores on some of the items may have been due to reading difficulties and that two of the items dealing with primes, composites, multiples and factors may have been too abstract for the students. They recommended that students be given more experience with word problems and the properties of zero, and that more emphasis be placed on estimation skills.

Computation with Fractions and Decimals

The Panel ratings of the 18 item-results in this objective showed the greatest variation of all the objectives as shown in Table 6-8. On one of the two items with the most

Table 6-8
Interpratation Panel Ratings
Grade 8: Fractions and Decimals

Rating	Number of Items
Strong	2
Very Satisfactory	0
Satisfactory	4
Marginal	8
Weak	4

highly rated results, 95% of students read a menu and correct-

ly calculated the cost of a meal. In the second item, students were required to solve a word problem involving fractions. Ninety-three percent of the students responded correctly to this item, B/14, which is reproduced in Figure 6-2.

B/14. Seven pies are to be cut into fourths. How many pieces will there be?

	% of students
14	2
7	1
28	93†
36	2
I don't know	2

Figure 6-2. Grade 8--Item B/14.

The results rated as Satisfactory included those involving subtraction of common fractions and ecimal fractions, and simple word problems involving subtraction of common fractions and multiplication of decimal fractions. Those rated as Marginal and Weak included items requiring the application of place value concepts, of comparison of fractions, of division of common fractions and decimal fractions, of multiplication of decimal fractions, and of conversion from common fractions to decimal fractionspercent.

The results on the items in this objective do not reveal weaknesses in computational skill but rather in estimation skills, fr-.tion concepts, and in understanding the behavior of zero. For example, the item which had the lowest percent of correct responses in the Grade 8 pool was item C/36, reproduced in Figure 6-3. In this item, students were asked to place the decimal point in a product. Whereas the correct answer was selected by only 7% of the students, 83% chose the answer which is obtained by the usually correct procedure of counting decimal places to position the decimal point. Members of the Interpretation Panel rated the results as Weak but commented that the item was unfair because the trailing zero had been omitted from the product. However, if one were to check responses by estimation, the correct option is easily identified.

C/36. The decimal point has not yet been placed in the answer to the exercise below:

358.6 x 0.25 = 8965

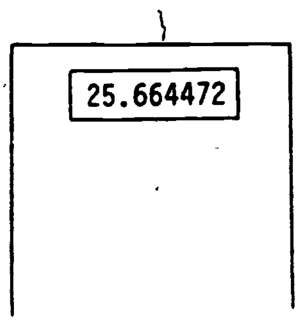
Which shows the correct placement?

	% of students
0.8965	2
896.5	4
8.965	83
89.65	7†
I don't know	2

Figure 6-3. Grade 8--Item C/36.

Similarly, the result for Item A/11, shown in Figure 6-4 was rated Weak. This item also involves estimation. Although the item is not an easy one, the correct answer would appear to be obvious after applying simple rounding and estimating.

A/11. The diagram shows a calculator display. Use estimation to decide which of the four exercises would have that answer.



	% of students
5.3269 x 4.8179 ...	38†
3.8245 x 7.93345 ..	27
144.971 0.56487 ..	9
133.427 10.6304 ..	8
I don't know	17

Figure 6-4. Grade 8--Item A/11.

Finally, performance on all items involving fraction concepts was rated as Weak. Item A/30, shown in figure 6-5 was repeated from the 1977 Assessment. It required students to find the largest of four fractions. One third of the students responded correctly. As in 1977, most students chose 2/3 as the correct response instead of 4/5. The reason for this is not clear.

A/30. Which number is largest?

	% of students
2/3	35
4/5	31†
3/4	20
5/8	11
I don't know	2

Figure 6-5. Grade 8--Item A/30.

Ratio, Proportion, and Percent

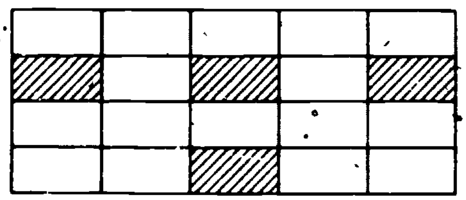
By the end of elementary school, students are expected to be able to work with, and have some understanding of ratio, proportion, and percent. In particular, students are expected to be able to solve simple proportions and to compute percentages. The Panel ratings for achievement on the items in this objective are found in Table 6-9. Most item-results were rated Marginal.

Table 6-9
Interpretation Panel Ratings
Grade 8: Ratio, Proportion, and Percent

Rating	Number of Items
Strong	0
Very Satisfactory	0
Satisfactory	3
Marginal	7
Weak	2

For Item A/20, reproduced in Figure 6-6, students were required to write a percent to represent the shaded portion of a region. Just over half of the responses were correct. Almost one third of the students simply counted the number of shaded regions. This performance was rated as Weak.

A/20. What percent of the figure is shaded?



	% of students
25%	7
4%	31
20%	54†
16%	6
I don't know	2

Figure 6-6. Grade 8--Item A/20.

The Panel commented that the test results showed that students had a poor grasp of the concepts of proportion and percent, especially of percents greater than 100%. Figure 6-7 shows Item B/26 which asked for a comparison between a number and 105% of that number. Although nearly 60% of the responses were correct, over 20% of the students responded "I don't know". This performance was also rated as Weak by the Interpretation Panel.

Item A/35 had a similar response pattern. This item, a scale question, had results rated as Marginal. It is reproduced in Figure 6-8. In fact the number of students choosing the "I don't know" response was over 15% on five of the twelve items for the objective, a much higher rate than on the other objectives in this domain.

<u>Summary</u>

The overall Panel rating of the results in the Number and Operation domain was Marginal. Although change from 1977 will be described at the end of the chapter, it should be noted that expectations of student performance may have changed since then. There is only one change item in this domain for

B/26. How does 105% of a number compare in size with the number?

	% of students
more than twice as large	10
less than half as large	7
slightly smaller	5
slightly larger	58†
I don't know	21

Figure 6-7. Grade 8--Item B/26.

A/35. The distance between two points on a map is 8.5 cm. What is the actual distance between the two points if the scale used in the map is 1 cm to 30 km?

	% of students
305 km	7
255 km	58†
205 km	8
830 km	6
I don't know	21

Figure 6-8. Grade 8--Item A/35.

which the score in 1981 is less than that in 1977, yet in four cases the Panel rating in 1981 is lower than in 1977 on the same item, and in no case is the Panel rating higher. In all, over the three objectives of the Number and Operation domain, a number of conclusions may be drawn. Student performance on items evaluating computational skills is at least

Satisfactory, but students have a marked difficulty with word problems and they are not adept at estimation or checking the reasonableness of answers. Neither do students appear to have an adequate grasp of fraction and percent concepts.

6.5 Domain 2: Geometry

The Grade 8 tests contained a total of 24 items in the Geometry domain. The items in each of the three objectives, Geometric Figures, Geometric Relationships, and Logical Reasoning, were distributed equally among the three test forms. Table 6-10 summarizes the results and the Interpretation Panel ratings for the objectives. Each of the objectives is discussed separately below.

Table 6-10
Grade 8: Geometry

Objective	Number of Items	Mean Percent Correct	Interpretation Panel Rating
Geometric Figures	6	57	M
Geometric Relationships	12	52	M
Logical Reasoning	6	69	S
Total	24	58	M

Geometric Figures

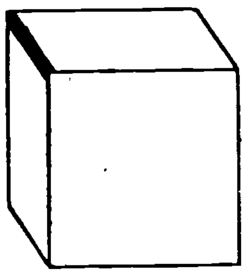
This objective contained six items, and the Panel ratings are shown in Table 6-11. Five items could be considered vocabulary or terminology items, and one required students to visualize an object in space. This last item, shown in Figure 6-9, was answered correctly by 72% of the respondents and that performance was rated Satisfactory by the Panel.

Of the remaining item results in this objective, one was rated Satisfactory, three Marginal, and one Weak. Knowledge of vocabulary and terminology was slightly improved over 1977 based on the three change items included in this objective.

Table 6-11
Interpretation Panel Ratings
Grade 8: Geometric Figures

Rating	Number of Items
Strong	0
Very Satisfactory	0
Satisfactory	2
Marginal	3
Weak	1

A/4. The heavy line shows one edge of the cube.
How many edges does the cube have?



	% of students
6	6
5	1
9	19
12	72†
I don't know	2

Figure 6-9. Grade 8--Item A/4.

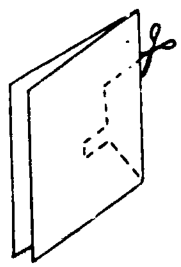
Geometric Relationships

The twelve items in this objective covered a wide range of content: spatial reasoning, elementary theorems in geometry, and symmetry. Panel ratings are found in Table 6-12. Student performance was rated as Strong and Very Satisfactory on the two spatial reasoning items of which Item A/42 in Figure 6-10 is an example. Performance on an item requiring students to estimate the number of degrees in an angle was also rated as Satisfactory.

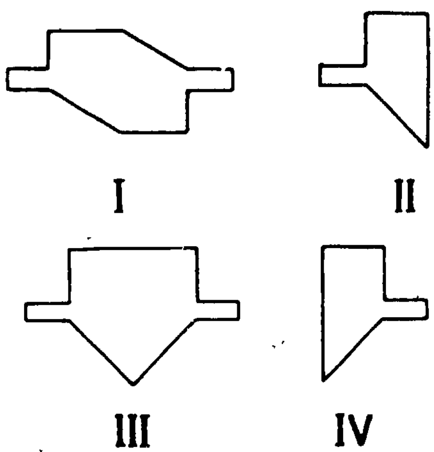
In the application of elementary theorems, only one fourth of the students correctly answered an item about the relationship between the sides of a triangle with equal base angles. Twenty-eight percent chose the "I don't know" res-

Table 6-12
Interpretation Panel Ratings
Grade 8: Geometric Relationships

Rating	Number of Items
Strong	1
Very Satisfactory	1
Satisfactory	2
Marginal	2
Weak	6



A/42. What will the figure above look like when it's cut out and unfolded?



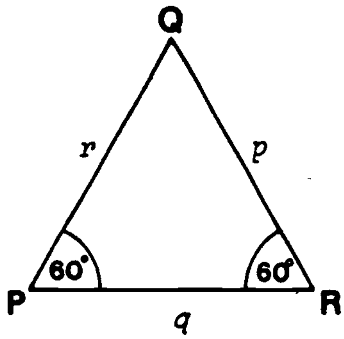
	% of students
I	2
II	5
III	90†
IV	2
I don't know	1

Figure 6-10. Grade 8--Item A/42.

ponse. This Item, C/39, is reproduced in Figure 6-11 and its results were rated Weak.

Only 17% of the students answered item A/41 correctly, (see Figure 6-12) an item dealing with the Pythagorean Theorem. The large number of students choosing the option containing the square root sign indicates that many may have been exposed to the theorem and recognized the need to extract a square root in one step of the solution, but the largest frac-

C/39. In ΔPQR, r =



	% of students
60	27
p	25†
q + p	17
q - p	3
I don't know	28

Figure 6-11. Grade 8--Item C/39.

A/41. The legs of a right triangle are 6 cm and 8 cm long. How long is the hypotenuse?

	% of students
48 cm	31
7 cm	10
100 cm	6
10 cm	17†
I don't know	36

Figure 6-11. Grade 8--Item A/41.

tion of students chose " I don't know". The performance on this item was rated Weak.

Logical Reasoning

As Panel members pointed out, logical thinking is not exclusive to geometry. However, because Euclidean Geometry has been used as the model for deductive reasoning for centuries, logic and geometry are often considered synonymous. The Logical Reasoning objective was placed in the Geometry domain

for convenience only. It could, with equal justification, have been placed in almost any of the other domains.

Performance on five of the six items in this objective was rated Satisfactory or better; the results on the remaining item were rated Marginal. Item C/12 is typical of the Logical Reasoning items and is illustrated in Figure 6-13. In these items, a class is described. The respondent is then required to decide whether or not an object is a member of that class. Given the difficulty of the item, the correct response rate of 62% was judged Satisfactory.

One cannot conclude on the basis of these items that students are learning logical reasoning as a by-product of mathematics alone. Indeed there may be a great deal of logical thinking taught during Language Arts, Reading, Social Studies, or Science. Whatever the source, it appears that students' ability to reason, at least as reflected by these items, is Satisfactory. The Panel commented that some sort of logical reasoning should be included explicity in the mathematics curriculum. It was the Panel's opinion that working non-routine problems would provide an opportunity for students to practice logical reasoning, and at the same time, improve problem solving skills in other areas.

C/12. NO STUDENT WHO GRADUATED FROM CENTRAL HIGH SCHOOL IS UNEMPLOYED.

Gerry is unemployed, so we may conclude that:

	% of students
Gerry did not graduate from Central High School	62†
Gerry went to Southside High School	2
Gerry did not go to school	6
Gerry did not go to Central High School	23
I don't know	7

Figure 6-13. Grade 8--Item C/12.

Summary

The most striking pattern which emerges from these results is the magnitude of the "I don't know" response. The average "I don't know" response on the items having results rated Marginal or Weak is 16%. The Panel felt that instruction in Geometry was being neglected. Similar comments were made by the Interpretation Panel in 1977. Panel members pointed out that because Geometry is traditionally taught at the end of the year and because it usually appears at the end of the textbooks, it tends to get left out due to lack of time. This problem is compounded .f teachers in later grades assume that the required material has been covered. The Panel suggested that instruction in Geometry be given a higher priority and that it be taught using practical applications.

6.6 Domain 3: Measurement

The Measurement domain consisted of 21 items grouped under two objectives: Metric Units; and Perimeter, Area, and Volume. The items in each objective were distributed equally among the three test forms. Table 6-13 summarizes the results for the Measurement domain.

Table 6-13
Grade 8: Measurement

Objective	Number of Items	Mean Percent Correct	Interpretation Panel Rating
Metric Units	9	57	M
Perimeter, Area, and Volume	12	37	W
Total	21	46	M

Metric Units

The Metric Units objective consisted of items dealing with temperature, length, and mass. The Panel ratings are found in Table 6-14. The Panel rated student performance on two of the length items as S`tisfactory and on one of the length items as Very Satisfactory. Performance on the fourth length item, requiring students to convert units, was rated as Weak. This weakness in converting units was observed in other items as well. Figure 6-14 contains Icem B/2 which is repre-

Table 6-14
Interpretation Panel Ratings
Grade 8: Metric Units

Rating	Number of Items
Strong	0
Very Satisfactory	1
Satisfactory	2
Marginal	3
Weak	3

B/2. A metre is about:

	% of students
the height of a dining room table	85†
the height of a grown man	4
the height of a skyscraper	1
the height of a mouse	5
I don't know	5

Figure 6-14. Grade 8--Item B/2.

sentative of the length items and on which student performance was rated Very Satisfactory. The Panel suspected that the good performance on length items was due to the fact that students have free access to metric rulers in the classroom and are therefore familiar with metric units of length.

Performance on the two temperature items was rated Marginal. Sixty-five percent of the students correctly identified 100°C as the boiling point of water, and 53% of the students correctly estimated the temperature on a sunny summer day, a decrease of 16% over the 1977 performance on the same estimation item. On the other two change items in this objective, student scores increased from 69% to 79% on a length item, and from 45% to 56% on the mass item, yet the Interpretation Panel ratings were not increased over the 1977 ratings of Satisfactory. In fact, the rating of performance on the mass item was reduced to Marginal from Satisfactory. It seems that here, as in other areas, the expectations of the

members of the Interpretation Panel exceeded those of the members of the 1977 Panel.

Some of the items discussed above could be considered metric usage items as opposed to unit conversion items discussed below. In light of the metric usage questionnaire, it is clear that students do not "think metric". With regard to the temperature items, many Panelists remarked on the use of British units on weather forecasts and the apparently poor attitude in the media toward metric conversion. Panel members also pointed out that there appeared to be a definite lack of feeling for metric units and that students might need more practical experience using metric units to measure objects.

Four of the items in this objective involved conversion of units. The one item result rated Satisfactory required students to convert five metres to centimetres. The other three items, all of whose results were rated Weak, each contained decimal fractions. Figure 6-15 shows Item B/44 which is representative of these items. Only 25% of the respondents could correctly combine three masses with different units, and one third chose the "I don't know" response. On each of the other two items 16% of the responses were "I don't know". The results indicate that students are not adept at converting units even though ease of unit conversion is a feature of the metric system. Because metric conversion depends heavily on place value concepts, it may be that the Weak performance on these items is a direct result of students' difficulty with place value concepts.

B/44. What is the combined mass of three objects having masses of 600 g, 1.02 kg and 32 g?

	% of students
1.652 kg	25†
2.04 kg	7
834 g	10
733.02 g	26
I don't know	33

Figure 6-15. Grade 8--Item B/44.

Perimeter, Area, and Volume

At the Grade 8 level it is expected that most students are able to calculate areas and perimeters of rectangles and triangles and also to calculate the volumes of right prisms. Of the twelve items dealing with these topics, one dealt with perimeter, four with volume, and seven with area. The Panel ratings are found in Table 6-15.

Table 6-15
Interpretation Panel Ratings
Grade 8: Perimeter, Area, and Volume

Rating	Number of Items
Strong	0
Very Satisfactory	1
Satisfactory	1
Marginal	4
Weak	6

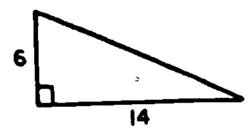
The single perimeter item was a word problem for which students were required to calculate the amount of fencing required to surround a rectangular garden. The correct response rate was 47% and the Panel rated that as Weak. This poor performance was consistent with performance on most of the word problems in this objective, and on word problems throughout the Grade 8 Assessment.

The best rating assigned to the results of any of the seven area questions was Marginal. Item A/40, reproduced in Figure 6-16, which had results rated Weak, required students to calculate the area of a right triangle. The most common mistake was for students to multiply the two given side lengths. This incorrect procedure also gave the most commonly chosen answer on the other triangle area question.

Two area items involved multi-step procedures to find the areas of parts of regions. Item B/18 shown in Figure 6-17 is one of these as well as being a change item. The "I don't know" response rate was 30% and performance was rated as Marginal.

On other area items, only 13% of students correctly estimated the area of a dollar bill and less than one quarter responded correctly to questions involving the relationship of the length of the sides of squares to their areas.

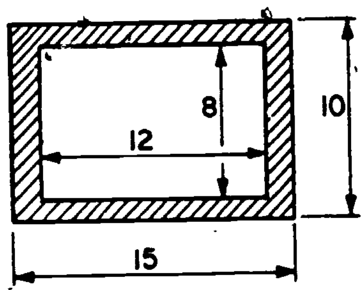
A/40. Find the area of this right triangle.



	% of students
42	27†
20	20
84	36
21	4
I don't know	14

Figure 6-16. Grade 8--Item A/40.

B/18. What is the area of the shaded portion of this figure?



	% of students
54	33†
96	21
120	7
60	10
I don't know	30

Figure 6-17. Grade 8--Item B/18.

Students' achievement for volume Item C/3, which is reproduced, in Figure 6-18, was rated as Very Satisfactory. This item is not only a word problem, but is a multi-step problem as well. Results were rated Satisfactory on a straightforward volume calculation, and Marginal on the two remaining items.

Summary

As noted above, students appear not to have a feeling for metric units, and their performance on word problems and

C/3. A rectangular pool of dimensions 4 x 5 x 6 has the same volume as another pool of dimensions 2 x 12 x h. What is the value of h?

	% of students
3	6
4	4
5	66†
6	7
I don't know	16

Figure 6-18. Grade 8--Item C/3.

multi-step problems is generally poor. Student performance on the three change items in this objective, however, has improved slightly since 1977.

6.7 Domain 4: Algebraic Topics

The Algebraic Topics domain included 39 items grouped under four objectives. Two of the objectives are presently covered in the B. C. Curriculum. The other two objectives, Probability and Statistics, are not. Table 6-16 contains the number of items, the mean percent correct, and the Panel ratings for each objective. The overall rating for the domain results was Satisfactory.

Table 6-16
Grade 8: Algebraic Topics

Objective	Number of Items	Mean Percent Correct	Interpretation Panel Rating
Expressions, equations, and inequalities	18	56	S
Graphs	6	64	VS
Probability	6	41	S
Statistics	9	44	S
Total	39	52	S

Expressions, Equations, and Inequalities

The overall rating for students' performance on this objective was Satisfactory. Panel ratings on item results are summarized in Table 6-17. The Panel commented that most questions were difficult and abstract. The students did very well on some items concerning evaluating and writing expressions.

Table 6-17
Interpretation Panel Ratings
Grade 8: Expressions, Equations, and Inequalities

Rating	Number of Items
Strong	0
Very Satisfactory	2
Satisfactory	6
Marginal	7
Weak	3

On items involving the writing and interpretation of formulas, achievement was rated as Marginal. Figure 6-19 contains Item C/35 which is an example of this type. For this, and similar items, the "I don't know" response rate averaged over 10%.

Results on two items involving equations were rated as Satisfactory, and results on two others were rated Weak. Those results rated as Satisfactory were achieved on items involving simple equations in one variable as illustrated by Item B/22 in Figure 6-20.

One of the equation items which had results rated as Weak called for students to solve the equation 3n=1. Forty-eight percent of the students chose the correct answer, 1/3. Thirty percent subtracted 3 from 1 to obtain -2. The fourth equation item, Item B/20, shown in Figure 6-21, was a difficult, non-routine problem. Considering the Panel's comments that the idea of variable did not seem well understood, the 16% "I don't know" response rate is understandable and the 42% correct response rate is encouraging in comparison to the low results on all non-routine items in the Assessment.

One item was concerned with the solution to an inequality. Linear inequalities are not emphasized in the intermediate grades so the 15% "I don't know" response rate is reasonable. However, the 54% correct response rate was rated as Marginal

C/35. The following formula has been used to determine the average mass for boys between the ages of 1 and 7:

$$M = 9 + 2A$$

where M is the average mass in kilograms and A is the boy's age in years.

According to this formula, for each year older a boy gets, how much more should he weigh?

	% of students
2 kg	30†
9 kg	28
11 kg	18
44 kg	3
I don't know	21

Figure 6-19. Grade 8--Item C/35.

B/22. Solve: $3x - 3 = 12$

	% of students
x = 7	2
x = 4	6
x = 3	9
x = 5	72†
I don't know	11

Figure 6-20. Grade 8--Item B/22.

by the Interpretation Panel.

B/20. What values of n make the sentence (n + 5) - 5 = n TRUE?

	% of students
0 only	26
0 and 5 only	12
all values of n	42†
no value of n	4
I don't know	16

Figure 6-21. Grade 8--Item B/20.

Graphs

Six items were used to assess students' ability to construct and interpret graphs. The Panel rated performance on four of the items as Satisfactory or better, on one item as Weak, and one item result, A/37, was not rated because the Panel felt that the wording of the statement of the question was ambiguous. These ratings are summarized in Table 6-18.

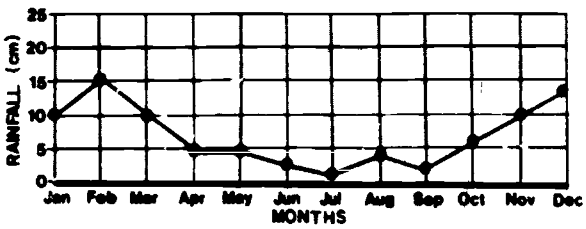
Table 6-18

Interpretation Panel Ratings
Grade 8: Graphs

Rating	Number of Items
Strong	1
Very Satisfactory	2
Satisfactory	1
Marginal	0
Weak	1
Not Rated	1

The items dealt with various types of graphs: bar, line, and circle. Item C/31, shown in Figure 6-22, is representative of the graphing items on which performance was rated Very Satisfactory.

C/31. For how many months was the rainfall more than 5 cm?



	% of students
3	5
4	5
6	85†
9	2
I don't know ...	2

Figure 6-22. Grade 8--Item C/31.

The one item on which student achievement was rated as Weak was obviously difficult for Grade 8 students. Figure 6-23 shows this item, B/19. In order to answer this question a student must have some understanding of the relationship between rate and slope. Most respondents chose the graph with the longest line segment as the one which represented the greatest rate.

The Panel was pleased with the results obtained on this objective. One member commented, however, that the interpretation of graphs is so important that even though the rating was Very Satisfactory, continued emphasis on graphing skills would be desirable.

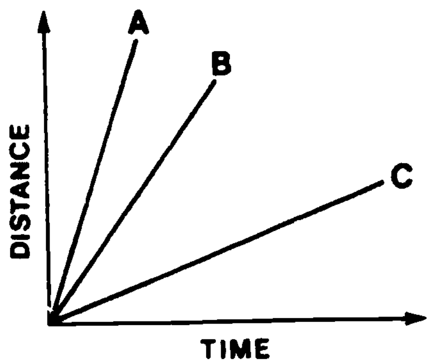
Probability

The Interpretation Panel commented that the students performed well on the the six probability items considering that this content is not presently in the curriculum. Item A/45 in Figure 6-24 shows a typical item and response pattern for items in this objective. On every probability item, less than half of the students responded correctly, and the "I don't know" rate was approximately 10%. Panel ratings are summarized in Table 6-19.

Statistics

Items in the Statistics objective assessed students' ability to interpret and make judgments about statements involving statistical information. Overall, student achievement on this objective was rated as Satisfactory. For two items in which information given in tables had to be interpreted, student performance was rated as Weak. For example, in Item C/40, shown in Figure 6-25, more students incorrectly chose 7 as the correct answer rather than 700, having not read

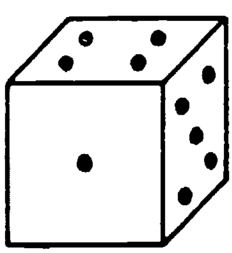
B/19. The graph shows the speeds of three cars, A, B, and C. Which car is travelling fastest?



	% of students
A	17†
B	2
C	42
Not enough information given	37
I don't know	2

Figure 6-23. Grade 8--Item B/19.

A/45. If on the roll of a die the probability that a five will appear is 1/6 then the probability that a five <u>or</u> a three will appear is:



	% of students
1/6	20
1/36	7
1/3	49†
1/12	14
I don't know	10

Figure 6-24. Grade 8--Item A/45.

Table 6-19
Interpretation Panel Ratings
Grade 8: Probability

Rating	Number of Items
Strong	0
Very Satisfactory	0
Satisfactory	5
Marginal	1
Weak	0

the table title carefully and failing to recognize that the numbers in the table were given in hundreds. Otherwise, results on items consisting of reading and interpreting tables and charts were rated as Satisfactory or better. The Panel ratings are found in Table 6-20.

C/40. How many passengers used the Fiske Airport in June?

AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers Per Month						Total
	Jan	Feb	Mar	Apr	May	Jun	
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

	% of students
26	12
28	11
700	31†
7	44
I don't know	1

Figure 6-25. Grade 8--Item C/40.

Table 6-20
Interpretation Panel Ratings
Grade 8: Statistics

Rating	Number of Items
Strong	1
Very Satisfactory	1
Satisfactory	2
Marginal	1
Weak	2
Not Rated	2

Results on the two items dealing with averages were rated as Satisfactory and Marginal. The item which obtained Satisfactory results was a change item. In 1977 the percentage of correct responses was 63%, in 1981, the percentage of correct responses was 64%. The item on which performance was rated Marginal was a difficult question and each of the options was a reasonable answer.

6.8 Domain 5: Computer Literacy

The Computer Literacy domain consisted of six items in a single objective. All items were knowledge items and the mean percent correct was 60%. The items in this domain were designed to assess students' knowledge of the capabilities, applications, and social impact of contemporary computers. The overall rating by the Interpretation Panel of the results in this domain was Satisfactory. Panel ratings for individual item results are found in Table 6-21.

Table 6-21
Interpretation Panel Ratings
Grade 8: Computer Literacy

Rating	Number of Items
Strong	0
Very Satisfactory	2
Satisfactory	1
Marginal	3
Weak	0

Four of the items had to do with non-technical aspects of computers, but the other two items were more technical in na-

ture. Students' achievement on the latter items was not as high as on the non-technical items, and they received Marginal ratings. Figure 6-26 contains one of them, Item C/37.

C/37. In order to solve a problem, a computer:

	% of students
must use punched cards	32
must have a set of instructions written by people	46†
must have solved a similar problem before	7
must have blinking lights	2
I don't know	13

Figure 6-26. Grade 8--Item C/37.

The Panel spent some time discussing the place of computer literacy in the schools. They commented that media influence on students' knowledge is very strong. Considering the responses to the background items about computer use in the schools, television, radio, and the newspapers may be the only source of information regarding the uses of computers for a large proportion of students. During the discussion of the results, the Panel made a distinction between computer use and computer literacy. They felt that computer literacy as defined above is a necessary part of a student's education ·· .eas programming skills are not needed by all students.

6.9 Changes in Achievement since 1977

The first B.C. Mathematics Assessment was carried out in 1977, and the data from that Assessment can serve as benchmarks against which changes in student performance may be measured. However, the structure of the 1981 Assessment differed from that of the previous one: the items were grouped under different domains and objectives and there were three test forms in 1981 compared to one in 1977. The Grade 8 change items, those items used on both Assessments at Grade 8, have been grouped in two Change Categories. These Change Categories

are not related to any of the domains or objectives previously discussed in this chapter up to this point. The two Change Categories, Number and Operation and Geometry and Measurement, are two distinct categories constructed for the sole purpose of comparing student performance.

The evaluation of the significance of change in student achievement over time is a complex task and there is no universal agreement as to the proper way to carry out such an evaluation. In the context of the Mathematics Assessment it is important to bear in mind that four years have elapsed since the first data were collected and that the data were collected from two different sets of students. No attempt has been made to apply tests of statistical significance to the change data.

Number and Operation

The Number and Operation change category consisted of fifteen items. Table 6-22 gives the test item number, the percent of students responding correctly, the percent change, and the Interpretation Panel ratings in each of the two Assessments. The data show that the 1981 results are generally higher than 1977 achievement. Of the fifteen items, only one shows a decline in performance and one shows no difference. Every other item shows improved performance.

Table 6-22
Grade 8: Change Category Number and Operation

Item Number		Mean Percent Correct		Change	Interpretation Panel Rating	
1977	1981	1977	1981		1977	1981
8	A/3	70	72	+2	M	S
17	A/12	66	69	+3	S	S
27	A/23	63	65	+2	S	S
47	A/30	29	31	+2	W	W
50	A/36	59	65	+6	S	M
12	B/6	42	42	0	M	W
18	B/17	32	37	+5	W	W
28	B/23	58	59	+1	M	M
36	B/30	66	74	+8	VS	S
49	B/40	79	84	+5	S	S
2	C/2	66	62	-4	M	M
13	C/13	55	61	+6	M	M
31	C/20	38	45	+7	M	M
34	C/23	73	74	+1	VS	S
30	C/25	72	76	+4	VS	VS
Mean Percent Correct		58	61			

Change comes slowly in Education. Methods, practices, and, presumably, student achievement levels are resistant to change. This apparent trend toward increased proficiency on the items in this Change Category is encouraging and may indicate the beginning of a long, gradual improvement in student achievement.

Geometry and Measurement

The Geometry and Measurement Change Category consisted of twelve change items table 6-23 gives the test item numbers, the percent of students responding correctly, and the Interpretation Panel ratings for each item in both Assessments. The same trend emerges in this change category as in the Number and Operation category. Overall, student performance in 1981 is superior to that in 1977.

Table 6-23
Grade 8: Change Category Geometry and Measurement

Item Number		Mean Percent Correct		Change	Interpretation Panel Rating	
1977	1981	1977	1981		1977	1981
19	A/15	69	53	-16	S	M
39	A/21	40	48	+8	M	M
41	A/28	59	64	+5	M	W
52	A/40	24	27	+3	W	W
20	B/15	69	79	+10	S	S
37	B/18	27	33	+6	W	M
40	B/28	63	62	-1	M	M
53	B/42	60	63	+3	M	M
22	C/17	45	56	+11	S	M
43	C/28	64	72	+8	S	S
38	C/30	69	72	+3	S	S
54	C/38	63	68	+5	S	S
Mean Percent Correct		54	58			

6.10 Reporting Categories

A student's achievement in Mathematics is the result of a large number of factors, both extrinsic and intrinsic to the student. Age, sex, and other attributes inherent in the student combine with curriculum variables and environmental

variables, such as teacher differences, to influence overall student performance. A great deal of information concerning the relationship between student background variables and achievement was collected in this Assessment, far more than can be fully discussed in a report of this length. From the large number of variables believed to be related to achievement, a smaller set of variables was selected and the relationship of these factors to performance was studied.

In the sections that follow, all of the results reported are based on correlational trends. No attempt is made to imply that cause-and-effect relationships exist since the Mathematics Assessment was not designed to identify such relationships. Thus, while the results show several strong relationships between a student's gender and performance, this does not imply that one's achievement is determined by one's sex. All that can be said is, that on the basis of the Assessment data, there appears to be a relationship. It remains for other studies designed as follow-ups to seek causal relationships.

The discussion of the reporting categories is based on a random sample of 10% of the students. Therefore, in these sections, the results of the tests of statistical significance used to evaluate the extent of any differences are given.

Sex Differences

There has been much interest shown in the differences in mathematics achievement between boys and girls. In the 1977 Assessment, the data appeared to support a growing body of literature which indicates that, starting around Grade 8, girls outperform boys only in those areas of mathematics at the lower cognitive levels.

The 1981 Assessment data were analysed in order to determine if there were any sex-related differences. Based on the 10% random sample of all students writing the tests, there are significant differences in achievement between boys and girls in some domains. In particular, boys' performance was significantly better than girls' ($p<0.01$) on all domains except Number and Operation.

Within the Number and Operation domain, girls' achievement was significantly greater than boys' ($p<0.02$) on one objective. That objective, Whole Numbers, contains a large proportion of knowledge and skill items, 10 out of 18. On the Ratio, Proportion, and Percent objective, there was a high proportion of analysis items, and the boys' achievement was significantly greater than the girls' ($p<0.01$). On the domain as a whole, boys' and girls' performances were about equal.

On every other domain boys' performance was significantly greater than girls'. Boys' performance was also significantly ($p<0.01$) higher on 7 of the remaining 10 objectives in these four domains. There were no significant differences in achievement between boys and girls on Geometric Figures, Logical Reasoning, and Expressions, Equations, and Inequalities.

First Language

One of the background items asked students whether or not English was their first language. Results show no clear pattern of superior achievement based on this partitioning of the population. In 1977 different questions were used to classify students according to language first learned, and items were grouped under different domains. At that time results indicated that students who had a non-English-speaking background performed well in mathematics and were not disadvantaged in that respect. Results of this Assessment indicate that students with a non-English-speaking background do about as well as those students with an English-speaking background.

Attitudes toward Mathematics

The Assessment data show that a positive attitude toward mathematics is moderately correlated with achievement in all domains except Computer Literacy.

6.11 Summary

The Grade 8 Assessment instruments consisted of three test booklets each containing 46 content items from a pool of 138 items grouped into thirteen objectives in five domains. Nine of the objectives assessed content currently prescribed in the B. C. Curriculum. The remaining four objectives dealt with content not presently prescribed but which may be considered for inclusion in future B. C. curricula. Twenty-seven items were repeated from the 1977 Assessment so that changes in student achievement could be examined.

In addition to the content items, the tests included twelve student background items and a 19-item scale designed to measure students' attitudes toward mathematics. The background and attitude items were common to each test form. All items were in multiple-choice format and students responded directly in the test booklets. Every content item had five options or response choices of which four were possible answers while the last option was "I don't know".

A total of 31 390 students responded on one or other of the test booklets. In those districts where samples of the students had written pilot forms of the test, only those stu-

dents from schools which had not participated in the piloting wrote the instruments in March.

Background Information

Based on the data gathered from the background information items, over 91% of the students were between 13 and 14 years of age at the time of testing in March. There was a slight imbalance of number of boys over number of girls. Over 90% of the students were currently enrolled in mathematics classes.

The background information also showed that although calculators are not used extensively in the classroom, over one third of the students use them at home. Computers are present in almost half the schools but they are not used extensively in mathematics classrooms. Results indicated that 73% of the students spend less than one half hour on mathematics homework, but only 8% do not have any mathematics homework assigned. Thirty-four percent of the students said that they sometimes use calculators to do homework. Information collected on students' facility with metric units indicated that students do not "think metric". The attitude items showed that most students feel positively about mathematics and that most would not voluntarily omit mathematics from their schooling.

Test Results

In the Number and Operations domain, student performance was rated as Marginal. Generally, students were able to perform calculations at a satisfactory level but had difficulty with place value, fraction and percent concepts, word problems, and estimating.

As a whole, performance in the Geometry domain was rated as Marginal, although performance on the non-curricular objective, Logical Reasoning, was rated as Satisfactory. In the Geometric Figures and Geometric Relationships objectives, students did well on items involving spatial reasoning but showed weaknesses in the knowledge of terms and in the application of elementary theorems. The response rate for "I don't know" was high, indicating that instruction in Geometry may need additional emphasis.

Results from the Measurement domain received a Marginal rating. Achievement on dealing with length was good, but not on those dealing with temperature or mass items. Results also indicated that most students are not able to convert from one metric unit to another, a skill related to place value concepts.

Student performance on perimeter, area, and volume items was rated as Weak. Students had difficulty with a perimeter word problem, and many were unable to find the area of a triangle or the area of a part of a rectangular figure. Results showed that students appeared to have poor measurement skills, and their performance on word problems and multi-step problems was Weak.

Grade 8 students performed at a Satisfactory level or better in the Algebra domain. Most students correctly answered straightforward items on equations and expressions, and their achievement in interpreting graphs was rated Very Satisfactory. Performance on the two non-curricular objectives in this domain, Probability and Statistics, was rated Satisfactory. As might be expected, many students indicated that they were unfamiliar with the content and vocabulary of these objectives by choosing the "I don't know" response.

The results of the items in the Computer Literacy domain indicated that most students have a good understanding of some of the most elementary ideas about the capabilities of modern computers. However, most students were not familiar with more technical aspects of computers. Student performance in this domain was rated as Satisfactory.

Changes in Achievement since 1977

Items were chosen from the 1977 Assessment instruments and included on the 1981 test for the purpose of measuring change in student achievement. These 27 change items were grouped in two Change Categories: Number and Operation, and Geometry and Measurement. These Change Categories are not the same as the content domains discussed above but are two distinct groupings constructed for the sole purpose of examining changes in performance.

Both Change Categories show similar patterns. Only three items showed declines in performance. Of the remaining items, 24 showed increases in achievement since 1977 and one item showed no change. The fact that performance increased on almost all of the change items is encouraging.

Sex differences

Boys outperformed girls on nine of the thirteen test objectives. On the test domains as a whole, there was little difference between boys' and girls' achievement in Domain 1, Number and Operation. However, on each of the other domains, boys' achievement was greater. In addition, Grade 8 boys' attitudes toward mathematics were found to be slightly more positive than girls'.

First language

Neither group of students, those whose first language was English, nor those whose first language was other than English, showed a consistent trend of higher achievement on the test objectives and domains. It appears that students with non-English-speaking backgrounds do about as well as students with English-speaking backgrounds.

Attitudes

Achievement in mathematics is moderately correlated with attitudes toward mathematics.

6.12 References

Klassen, W., Dukowski, L., and de Groot, I. Item preparation for the 1981 Mathematics Assessment. Vector, 1981, 22, 2, 22-25.

CHAPTER 7

GRADE 12 RESULTS

Ian C. de Groot and James M. Sherrill

The results obtained on the Grade 12 Mathematics Assessment instruments for each objective assessed are presented and discussed in this chapter. Some of the items from the Assessment instruments are included as illustrative examples to clarify points made in the report. All percents reported in this chapter, or displayed in tables, have been rounded to the nearest whole number.

The same items were also given to a sample of Grade 10 students, and these results will be discussed along with those from Grade 12. Throughout this chapter, students who wrote the Grade 10 instrument will be referred to as the Grade 10 sample.

Several items were repeated from the 1977 Mathematics Assessment. These items, known as change items, were repeated in order to measure the degree of change since 1977. This change and its implications will be discussed in later sections of this chapter.

The Grade 12 Interpretation Panel was charged with the task of rating each item, objective and domain based on the overall Grade 12 results. The ratings given by the Panel for each item were based on the opinions of that group reacting to the results of the item under consideration. The Interpretation Panel's ratings were on a five-point scale using the following descriptors:

- Strong (ST)
- Very Satisfactory (VS)
- Satisfactory (S)
- Marginal (M)
- Weak (W)

All of the ratings for each domain and objective and some comments of the Interpretation Panel are included in this chapter.

7.1 Description of the Instruments

The two test booklets contained a total of 90 items, 45 in each of Booklets A and B. These booklets have been reproduced as Appendix H.

The aim of the Grade 10 and Grade 12 instruments was not to evaluate individual courses, but to assess the mathematics achievement levels of all students in the province. The items were designed to assess students' mastery of 13 objectives in 5 domains over the 3 cognitive levels of Knowledge, Comprehension, and Application. The distribution of items by domain and cognitive level is presented in Table 7-1.

Table 7-1
Number of Items by Cognitive Level and by Domain

Domain	Knowledge	Comprehension	Application	Total
Number and Operation	3	13	6	22
Geometry	10	1	7	18
Measurement	8	1	3	12
Algebraic Topics	13	7	12	32
Computer Literacy	6	0	0	6
Total	40	22	28	90

The Contract Team, with the assistance of the Advisory Committee, selected the items that were to be used in each domain and at each cognitive level. The decision was based on several factors such as the number of objectives in the domain and the importance of assessing certain basic concepts.

One of the domains measured, Computer Literacy, was included in the Assessment for the first time mainly for the collection of base-line data. Similarly, two of the objectives, Probability and Statistics, in the Algebraic Topics domain and Logical Reasoning in the Geometry domain, were also in the Assessment for the first time. These objectives deal with content which is not included in the present curriculum prescribed in B. C. They were included in the Assessment to measure students' performance on topics considered important by such groups as the National Council of Teachers of Mathematics and the National Council of Supervisors of Mathematics. The results of students' performance on these items should be useful in any future review or revision of the mathematics curriculum in the province. The number of items on

each form assessing topics not currently in the B. C. curriculum is presented in Table 7-2.

Table 7-2
Grades 10 and 12: Non-Curricular Objectives

Domain	Objective	Items/Form
Geometry	Logical Reasoning	3
Algebraic Topics	Probability	3
	Statistics	3
Computer Literacy		3

In addition to the mathematics achievement items, the instruments contained 18 background information items and a 19-item scale measuring students' attitudes toward mathematics. The students were asked to complete all of these information items before attempting the achievement items.

Students responded to the items in the booklets by placing an "x" beside their response choice. All items in the booklets were of the multiple-choice type. For each item, five responses were given. Of these, four were possible answers to the item and the fifth was "I don't know".

Forty-five minutes were allotted for the completion of the entire booklet. This permitted teachers time to give instructions and complete and collect the instrument within a regular classroom period.

7.2 Description of the Population

The numbers of Grade 10 and Grade 12 students who participated are shown in Table 7-3.

Table 7-3
Grades 10 and 12: Number of Students Responding

Group	Booklet A	Booklet B	Total
Grade 12	12 208	12 258	24 466
Grade 10	1 227	1 229	2 456

The Grade 12 Assessment population consisted of 24 466 students enrolled in Grade 12 regardless of whether they were studying mathematics or not. The Grade 10 Assessment was made up of a provincial sample of Grade 10 students.

Distribution by Sex, Age, and Mother Tongue

As expected, the Grade 12 and Grade 10 samples were evenly divided between males and females with Grade 12 females having a 1% plurality and Grade 10 males having a 3% plurality. In each case there were 3% who did not respond to the item. In 1977 the Grade 12 females had a 3% plurality.

The 17 - 18 year olds accounted for 93% of the Grade 12 sample with 62% of the sample being 17 years old. Five percent of the sample was 19 years old or older.

For over 90% of the students in the Grade 12 and Grade 10 samples English was the language usually spoken in the home. English was also the language they first learned to speak for over 85% of the two groups of students.

Mathematics Background

Mathematics is compulsory for all students in B. C. up to and including Grade 10. Only one course is officially prescribed at each level, but there are local variations of the Mathematics 10 course. For example, some students are placed in Mathematics 10 core classes in which basic essentials are emphasized. All mathematics courses taken after Grade 10 are electives. The distribution of mathematics background by sex is presented in Table 7-4.

Table 7-4
Grade 12: Distribution of Mathematics Background by Sex
(Percent)

Courses	Male	Female	Percent of Grade 12 Population
Algebra 11 (or 11 Enriched)	51	49	63
Consumer Mathematics 11	41	59	18
Trades Mathematics 11	88	12	11
Computing Science 11	70	30	8
Algebra 12 (or 12 Enriched)	58	42	38
Geometry 12	73	27	6
Probability & Statistics 12	62	38	3
Other	50	50	7

Even with the introduction of the optional courses, the algebra courses are predominant with 38% of the Grade 12 students having taken Algebra 12 or Algebra 12 Enriched. In the two other Grade 12 courses, the proportion of males is approximately double the proportion of females.

The distribution for Algebra 12 remains virtually unchanged from 1977. At that time, females accounted for 43% of the enrolment in Mathematics 12 as opposed to the present enrolment in Algebra 12 of 42%.

The results show a slight change from the results of the 1977 Mathematics Assessment. In 1977 females formed 65% of the group which took no mathematics beyond Mathematics 10. The 1981 results show that females now constitute 68% of the group which took no mathematics beyond Mathematics 10.

In 1977, females comprised 54% of the group that took no academic mathematics beyond Math 11. The present results show that this figure is now 49%.

Three of the new elective courses in the B. C. curriculum since the 1977 Mathematics Assessment, Computing Science 11, Geometry 12, and Probability and Statistics 12, have only marginal appeal, as the results show. This may be due to the specialized nature of the courses and to the fact that secondary students have many areas other than mathematics from which they may choose elective courses.

It is to be noted that 7% of the Grade 12 population take courses other than those prescribed in the curriculum guide. These may be locally developed courses such as Computing Science 12, Calculus 12, and General Mathematics 12.

Calculators

Students were asked to respond to the same three questions concerning the use of calculators as they were asked in the 1977 Mathematics Assessment. The data are summarized in Table 7-5.

The results indicate a significant change in the use of calculators since 1977. In the 1981 Mathematics Assessment 13% more Grade 12 students responded that they use calculators at home, 20% more used calculators for homework, and 23% more used calculators in school. The data obtained from the Grade 10 sample also show that a majority of the students used calculators at home, for homework, and in school. These results probably reflect changing attitudes on the part of both the general public and mathematics teachers toward the use of calculators in the learning and teaching of mathematics.

Table 7-5
Grade 12: Calculator Usage
(Percents)

Response	Do You Use a Calculator At Home? 1977*	1981*	For Homework? 1977	1981	In School? 1977	1981
Yes	51	64	56	76	51	74
No	48	35	43	23	47	25
No Response	1	1	1	1	1	1

*1977-Results from the 1977 Mathematics Assessment; 1981-Results from the 1981 Mathematics Assessment

Mathematics curriculum designers should take into account this trend toward increased usage and integrate the calculator into the mathematics curriculum.

Computers

Sixty-seven percent of the Grade 12 students and 57% of the Grade 10 students responded that there was a computer in their school. One implication of such a finding is that many students are graduating from secondary school with ability to use the computer.

Of the Grade 10 students who had taken classes in which a computer was used, 45% had used a computer in their mathematics classes and 22% in a computer science class. Of the Grade 12 students who had taken classes in which a computer was used, only 24% had used a computer in their mathematics classes and 30% in a computer science class.

The recent growth of the use of computers in schools can be described as impressive. This new presence of computers in the high schools of the 1980s is a reality for which all mathematics teachers will have to be prepared. Teachers should prepare by acquiring computer literacy through in-service programs made available by the Ministry of Education and the local school districts.

Homework Assignments

Students presently enrolled in a mathematics course, were asked how long it had taken them to do their last mathematics homework assignment. The results are summarized in Table 7-6.

Sixty-nine percent of the Grade 12 group currently enrolled in a mathematics course responded that they spent between 11 minutes and 60 minutes doing their most recent

Table 7-6
Grades 10 and 12
Time Required to do Most Recent Homework Assignment
(Percent)

	Grade 10	Grade 12
No Homework	11	7
Between 1 and 10 minutes	19	11
Between 11 and 30 minutes	48	43
Between 31 and 60 minutes	17	26
More than one hour	5	13

mathematics homework assignment. For the corresponding interval, the Grade 10 sample had a 65% response. These data suggest that the majority of mathematics students spend a significant amount of time out of the classroom working mathematics homework assignments.

The data show that a large group of Grade 12 students, 60%, were not enrolled in any mathematics course when this Assessment was conducted. Almost half of the Grade 12 students responded that they had not had any mathematics courses for at least one school year.

Part-time Employment

The Grade 12 students and the Grade 10 students were asked two questions concerning part-time employment. The questions concerned how many hours per week they worked and when during the week they worked. The data are presented in Tables 7-7 and 7-8.

Table 7-7
Grades 10 and 12: Part-time Employment
(Percent)

Response	Do You Have a Part-time Job? Grade 10	Grade 12
No	49	34
Weekends Only	15	19
Weekdays Only	4	5
Both Weekends and Weekdays	24	38

The data show that a significant proportion of Grade 12 students, 38%, work all week. At the Grade 10 level, 49% did not work at all, while 24% work all week.

Table 7-8
Grade 10 and 12: Number of Hours Worked
(Percent)

Number of Hours/Week	Grade 10	Grade 12 1977	Grade 12 1981
1 - 5	7	5	4
5 - 10	13	15	16
10 - 20	17	23	28
More than 20	6	11	13
No Response	57	47	38

The results of the 1977 Mathematics Assessment showed that 34% of the Grade 12 students worked more than 10 hours per week, whereas the present results show that the proportion has increased by 7%. In comparing the present data with the results of the 1977 Assessment, it appears that students are pursuing part-time occupations more than before.

Future Plans

Sixty-four percent of the Grade 12 group and 59% of the Grade 10 sample indicated their intentions of pursuing further education upon graduation from secondary school. The data regarding students' future plans are presented in Table 7-9.

The data displayed in Table 7-9 show some change since the 1977 Mathematics Assessment. At that time 21% of the Grade 12 group planned to attend university, as compared to 17% presently. In the last Assessment, 6% of Grade 12 students planned to attend a technical institute, 18% planned to attend a community college in either one of their speciality areas, 9% planned to enrol in vocational, art, or trade school, and 19% planned to go to work. Since the two choices concerning taking a year off before pursuing either a job or further education were not on the 1977 Assessment instruments, direct comparison of the results between the two assessments is difficult.

The Grade 12 students were asked if they plan to attend a post-secondary institution after graduation. If they responded positively, they were asked which college, institute, or university they planned to attend. The list of colleges, institutes, and universities in B. C. was provided.

Twenty-one percent of the Grade 12 students responded that they planned to attend one of the 14 colleges listed. No single college dominated, with Douglas College, the most commonly selected college, being selected by 4%. Ten percent of the Grade 12 students planned to attend one of B. C.'s 6 ins-

Table 7-9
Grades 10 and 12: Students' Future Plans
(Percent)

Plans	Grade 10	Grade 12
Further Education	59	64
Business School	3	2
Vocational, art or trade school	8	8
Technical Institute	5	5
Community College: University transfer program	4	11
Community College: career program	6	8
University	26	17
Take a year off and then pursue education	7	13
Enter the Job Market	11	13
Look for a job	10	12
Take a year off and then look for a job	1	1
Other	30	23
Other plans	5	8
Undecided	18	8
No response	7	7

titutes with 95% of them selecting either B.C.I.T. or Pacific Vocational Institute. Sixteen percent of the Grade 12 students planned to attend one of B. C.'s four universities, with 56% of them selecting U.B.C.

The most commonly (selected by at least 5% of the sample) selected areas of study were Business management and sciences and Health professions and occupations. Mathematics and physical sciences, together, were selected by less than 2%.

Metric Usage

Students were asked four questions involving measurement in order to assess the degree to which they tend to use metric units. The questions were given with two correct responses, one in metric units and the other in imperial units. They were asked to choose the answer which most readily came to mind. The questions and the percent responding for both the Grade 10 and Grade 12 groups are presented in Table 7-10.

The responses to these questions show that secondary school students are still a long way from "thinking metric". The most favorable response occurred on the question involving temperature, but even there the majority of students selected the temperature expressed in Fahrenheit degrees.

Table 7-10
Grades 10 and 12: Metric Usage Questions
(Percent)

Question	Grade 10	Grade 12
1. How much does a bicycle weigh?		
About 15 kilograms	18	16
About 35 pounds	81	82
2. What is the temperature in this room?		
About 70 degrees	64	59
About 20 degrees	35	40
3. How far is it from Prince George to Prince Rupert?		
About 700 kilometres	24	22
About 450 miles	74	77
4. How much gasoline can the gas tank in a large car hold?		
About 20 gallons	81	79
About 90 litres	17	19

The mathematics curriculum guide states that all mathematics for years K-12 should be completely metric by 1978. Since all prescribed mathematics texts are now metric, it is presumed that the metric system is the system taught and used by the large majority of mathematics teachers. It is becoming more evident, however, that a greater effort will have to be made by all levels of government to educate the public at large and encourage all citizens to use the metric units.

7.3 Students' Attitudes Toward Mathematics

Each assessment booklet included a 19-item scale entitled Mathematics and Myself. These items were designed to measure students' attitudes toward mathematics. Different attitude components such as anxiety, motivation, self-concept, and enjoyment of mathematics were reflected in these items.

The students responded to each item by marking one of the following: Strongly Agree, Agree, Can't Decide, Disagree, Strongly Disagree.

One cannot generalize from a single statement on an attitude scale so a global score was computed for the students. A summary of the results are presented in Table 7-11.

The results show that more students feel positive toward mathematics than negative. Fifty-three percent of the Grade 10 sample and 41% of the Grade 12 group have a positive attitude

Table 7-11
Grades 10 and 12: Attitude Toward Mathematics
(Percent)

Attitude	Grade 10	Grade 12
Strongly Positive	9	6
Positive	44	35
Neutral	38	41
Negative	8	16
Strongly Negative	0	2

toward mathemtics. At the other end of th. scale, 8% of the Grade 10 sample and 18% of the Grade 12 group have a negative attitude toward mathematics.

The data from two items of the attitude scale are presented in Table 7-12. While one cannot generalize from the results on these two items, they were selected as being representative of the overall results.

Table 7-12
Grade 10 and 12: Results on Items 1 and 3 on the Attitude Scale
(Percent)

Item	Response			
	Positive		Negative	
	Grade 10	Grade 12	Grade 10	Grade 12
I really want to do well in mathematics.	92	77	2	9
I am looking forward to taking more mathematics	49	24	27	50

The general trend of the Grade 12 results being less positive than the Grade 10 results is reflected in the data in Table 7-12. Also the data in Table 7-12 show the trend of both groups of students being more positive about wanting to do well in the mathematics they are taking than in wanting to take more mathematics.

7.4 Domain 1: Number and Operation

The 22 mathematics content items given for the domain of Number and Operation were divided among three objectives: Number Concepts, Computation with Fractions and Decimals, and Ratio, Proportion, and Percent. Ten of the items were change items which were used in the 1977 Mathematics Assessment. In this section the results for the objectives are reported for each domain. The Interpretation Panel's rating for this domain was Marginal. The number of items, mean percent correct, and the rating organized by objective are displayed in Table 7-13.

Table 7-13
Grade 12: Number and Operation Domain

Objective	Number of Items	Grade 12 Mean Percent Correct	Panel Rating
Number Concepts	6	55	M
Fractions and Decimals	10	60	M
Ratio, Proportion and Percent	6	63	S

The mean percent correct for each domain was computed. For the Number and Operation domain, it was 59% for the Grade 12 group, and 55% for the Grade 10 sample.

Number Concepts

There were three items on each form for a total of six items for this objective. The items included in this objective were designed to assess students' comprehension of and ability to use mathematical concepts such as scientific notation, order of operations, estimation of the results of numeric operations, and place value.

The mean percent correct response for the Grade 10 sample for this objective was 53% and for the Grade 12 group, 55%. These results are the first instance of a consistent pattern. The Grade 12 results and the Grade 10 results are very similar on all objectives.

The Interpretation Panel rated the results for this objective as Marginal, with one item rated as Very Satisfactory, two as Satisfactory, one as Marginal, and two as Weak. The Panel was particularly concerned with the results of questions involving estimation. For example, performance on Item B/20, shown in Figure 7-1, was rated as Marginal.

B/20. The closest estimate for $\sqrt{640}$ would be:

	% of students Gr.10	Gr.12
20	8	8
30	8	6
25	43	46†
80	36	34
I don't know ..	5	6

Figure 7-1. Grades 10 and 12--Items B/10 and B/20.

The intent of Item B/20 was to determine whether students recognized that 640 is between 625 and 900, a first step in estimating square roots. Thirty-six percent of the Grade 10 sample and 34% of the Grade 12 group estimated the result to be 80. They may have considered that since the square root of 64 is 8 then the square root of 640 should be 80.

In view of the contemporary role of calculators in mathematics, many educators feel that experiences involving the skill of estimation should be interspersed throughout the mathematics curriculum. Estimation activities could be incorporated into all areas of the mathematics curriculum, thereby encouraging the use of estimating skills to assess the reasonableness of results.

The results for Item A/6, an item involving scientific notation, and Item A/12, an item involving rounding to the nearest tenth, are displayed in Figure 7-2.

The results of Item A/6 were rated as Very Satisfactory by the Interpretation Panel, but the results of Item A/12 were

A/6. Expressed in scientific notation, the depth of a certain part of the ocean is 3.6×10^2 metres. What is the value of 3.6×10^2?

	% of students Gr. 10	Gr. 12
36	2	1
3600	27	27
1296	0	1
360	67	66†
I don't know ..	4	4

A/12. 31.8 L is a measurement which has been rounded to the nearest tenth. Which of the following is not a possible value for the measurement before it was rounded?

	% of students Gr. 10	Gr. 12
31.76 L	6	4
31.80 L	10	7
31.749 L	47	49†
31.849 L	25	30
I don't know ..	11	9

Figure 7-2. Grades 10 and 12--Items A/6 and A/12.

rated as Weak. The low success rate on Item A/12 may have been due to the way in which the item was worded. The results for this objective suggest that the students had higher success rates on those items which were worded in a familiar manner.

Computation with Fractions and Decimals

The 10 items for this objective were chosen to assess the students' ability to perform basic operations with decimals and fractions and to solve verbal problems that involve the use of these skills. The mean percent of correct responses for the Grade 10 students was 55% and for the Grade 12 students it was 60%.

The Interpretation Panel rated the results of this objective as Marginal, even though they rated the results of one of the items in this objective as Very Satisfactory, four as Satisfactory, three as Marginal and two as Weak. They felt that the students' treatment of questions involving common fractions left room for improvement. One of the items the Panel rated as Weak is presented in Figure 7-3.

B/19. Five times as many people visit a zoo on Saturdays as on each of the other days of the week. What fraction of the weekly visitors come to the zoo on Saturdays?

	% of students Gr.10	Gr.12
5/7	65	62
2/5	8	7
5/12	6	7
5/11	7	12
I don't know ..	15	13

Figure 7-3. Grades 10 and 12--Item B/19.

As the results show, this item was interpreted incorrectly by most students. The results may be as indicative of a weakness in problem solving skills as of a weakness with fractions.

The students tended to have less difficulty with items that involved operations with decimals, whereas both the Grade 10 sample and the Grade 12 group were less successful with items involving operations with fractions.

There appears to be a changing emphasis in the treatment of fractions by many mathematics teachers. This shift of emphasis could possibly be due to two factors: the increased use of calculators, as was previously shown in Table 7-5, and the increased use of the metric system of measurement in mathematics.

Ratio, Proportion, and Percent

The six items listed under this objective were chosen to measure students' knowledge of and ability to apply the concepts of ratio, proportion, and percent. The Interpretation Panel rated the overall results of this objective as Satisfactory. They rated the results of one of the items as Very Satisfactory, three as Satisfactory, and two as Marginal, one of which is shown in Figure 7-4. The mean percent correct response for the Grade 10 sample was 57% and for the Grade 12 group it was 63%.

A/37. The lengths of two coils of rope are in the ratio of 7 to 9. Find the length of the longer segment, if the shorter is 9 m long.

	% of students Gr.10	Gr.12
8 1/7 m	39	45†
81 m	17	13
7 m	14	12
9 m	2	1
I don't know ..	29	29

Figure 7-4. Grades 10 and 12--Item A/37.

Twenty-nine percent of both the Grade 10 and Grade 12 groups responded that they did not know the solution. The Interpretation Panel felt that more emphasis should be placed on questions involving problem solving with the use of ratios and proportions.

The two items in this objective that involved the changing of either decimals or common fractions to percent both elicited a 76% correct response from the Grade 10 sample and

an 80% and 76% correct response from the Grade 12 group. It appeared that the students' had an overall positive performance on questions involving percent but on questions involving ratios their performance was lower.

7.5 Domain 2: Geometry

There were 18 items in the Geometry domain. Four of these items were repeated from the 1977 Mathematics Assessment. The domain was composed of three objectives: Geometric Figures, Geometric Relationships, and Logical Reasoning. The number of items, the mean percent correct, and the ratings are displayed in Table 7-14 by objective.

Table 7-14
Grade 12: Geometry Domain

Objective	Number of Items	Grade 12 Mean Percent Correct	Panel Rating
Geometric Figures	6	56	S
Geometric Relationships	6	49	M to S
Logical Reasoning	6	79	VS

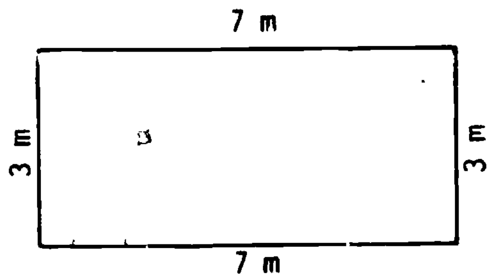
The mean percent correct for Domain 2 for the Grade 12 group was 61% and for the Grade 10 sample was 59%. The Interpretation Panel's overall rating, for the Grade 12 group, for Domain 2 was between Satisfactory and Very Satisfactory.

Geometric Figures

The six items on this objective were designed to assess students' ability to identify the parts of basic geometric figures such as circles, rectangles, triangles, and cubes, and to perform calculations involving these parts. The Interpretation Panel rated the Grade 12 students' performance as Satisfactory for this objective. The Panel felt that the only weakness in this objective was the performance on items that required knowledge of definitions. The mean percent correct for the Grade 10 sample was 55% and for the Grade 12 group it was 56%. The item with the lowest mean percent correct for the Grade 10 sample is shown in Figure 7-5.

This was an example of an unusual question. The low percent correct for this item may have been due to the fact that all of the choices were necessary for the figure to be a rec-

A/29. In the figure below, the lengths of the sides are shown. Which one of the following ensures that the figure is a rectangle?



	% of students Gr.10	% of students Gr.12
the opposite sides are congruent	36	30
the opposite angles are congruent	8	8
the angles are right angles	17	24†
the opposite sides are parallel	33	32
I don't know	5	6

Figure 7-5. Grades 10 and 12--Item A/29.

tangle, but the key word in the question is "ensures". This may have been an indication of the difficulty that students had in reading and interpreting certain questions.

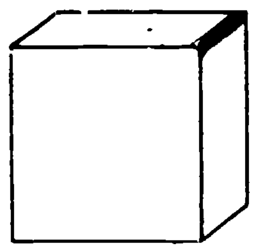
An example of why the Panel rating was Satisfactory is the result on Item B/27 in Figure 7-6. This item, which illustrated students' familiarity with certain geometric figures, had a very high success rate.

The Interpretation Panel rated three of the items for the Grade 12 group, for this objective, as Very Satisfactory, one as Satisfactory, and two as Weak.

Geometric Relationships

This objective was selected to assess students' knowledge of relationships that involve angles, parallel lines, similar triangles, right-angle triangles, and circles. The mean percent correct response for the Grade 10 sample was 46% and for the Grade 12 group it was 49%.

B/27. The heavy line shows one edge of the cube. How many edges does the cube have?



	% of students Gr.10	Gr.12
5	1	1
6	5	4
9	7	8
12	85	86†
I don't know ..	2	2

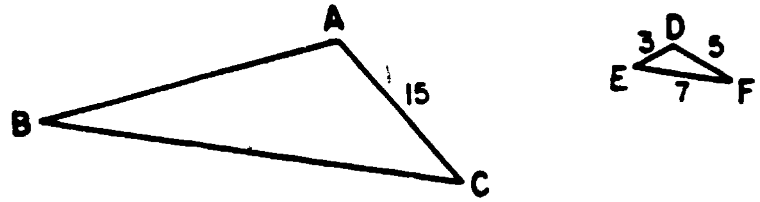
Figure 7-6. Grades 10 and 12--item B/27.

The Interpretation Panel felt that it could not decide, from the results of this objective, on one specific rating. Based on the overall performance on this objective by the Grade 12 group, the Interpretation Panel rated the results somewhere between Marginal and Satisfactory. The Panel rated the performance on one item as Very Satisfactory, two as Satisfactory, two as Marginal, and one as Weak. They felt that this objective was not a reliable indication as to which topics involving geometric relationships should be in the mathematics curriculum. An item that caused some confusion, Item A/42, is shown in Figure 7-7.

Approximately 60% of the students in both groups chose the first answer. They may understand the concept of similar figures but were confused by the triangles not being oriented in the same manner.

The overall success rate at the Grade 12 level of 49% for this objective suggests that mathematics teachers need to reinforce basic geometric relationships throughout the mathematics curriculum. Mathematics teachers should encourage more students to enroll in Geometry 12, which presently has an enrollment which represents only 6% of the Grade 12 students.

A/42. Triangle ABC is similar to triangle DFE.
Find the length of segment BC.



	% of students Gr.10	% of students Gr.12
21	59	60
15	2	3
35	25	21†
45/7	2	2
I don't know ..	12	13

Figure 7-7. Grades 10 and 12--Item A/42.

Logical Reasoning

The study of mathematics is presumed to develop students' ability to reason logically. It was decided to include Logical Reasoning, an objective mentioned only at the Grade 8 level, for two purposes: to measure students' ability to reason in an organized manner and to determine if students draw appropriate conclusions from a given set of facts.

Although logical reasoning is a necessary component throughout the study of mathematics and this objective could have been included in any other domain, it was considered appropriate to include it in the domain of geometry since it is generally accepted that logic is an inherent component in the formal study of geometry.

The results for this objective were rated Very Satisfactory by the Interpretation Panel. The results for three of the items were rated as Strong and the results for the other three items were rated as Satisfactory. The Panel felt that the high success rate was indicative of the fact that a reasonable transfer of learning was occurring. The mean percent correct for the Grade 10 sample was 75%, and for the Grade 12 group it was 79%.

7.6 Domain 3: Measurement

The domain of Measurement in this Assessment had two objectives--Metric Units and Perimeter, Area, and Volume. A total of 12 items, of which five were change items, comprised this domain.

The number of items, mean percent correct, and ratings are displayed in Table 7-15 by objective.

Table 7-15
Grade 12: Measurement Domain

Objective	Number of Item	Grade 12 Mean Percent Correct	Panel ating
Metric Units	6	66	S
Area and Volume	6	48	M

The mean percent correct for the Grade 12 group, 57%, was once again slightly greater than that for the Grade 10 group which was 55%. The Panel's rating for the domain was Marginal.

Metric Units

The six items involving metric units were designed to measure sutdents' ability to work within the metric system of measurement. The mean correct response for the Grade 10 sample was 62% and for the Grade 12 group it was 66%. The Interpretation Panel's rating for this objective was Satisfactory. The Panel rated the results of three of the six items as Weak, and of each of the other three items as Satisfactory, Very Satisfactory, and Strong.

The question involving temperature had the greatest success rate. This was probably due to the fact that temperature in degrees Celsius is the metric measure used most often in everyday life by Grade 10 and Grade 12 students.

Three items in which students had to convert within the metric system caused some difficulty and students' performance on these items was rated as Weak by the Interpretation Panel. The results for Item A/11, an item involving conversion from kilometres to metres, are presented in Figure 7-8.

A/11. How many metres are in 0.65 km?

	% of students Gr.10	Gr.12
65	25	22
650	51	53†
6.5	11	10
0.65	2	2
I don't know ..	11	13

Figure 7-8. Grades 10 and 12--Item A/11.

The Interpretation Panel rated the results for Item A/11 as Weak. On the other hand, the results of the conversion from metres to centimetres were very positive, as indicated by the data in Figure 7-9, and were rated Very Satisfactory.

B/12. 5 metres is the same length as:

	% of students Gr.10	Gr.12
50 centimetres	5	7
500 centimetres	87	85†
50 millimetres	1	1
500 millimetres	3	2
I don't know	3	5

Figure 7-9. Grades 10 and 12--Item B/12.

There are two possible explanations for the different results to the two items that involve the same process. The first explanation could be that students sometimes have difficulty in converting from larger units to smaller units; the

second, and more likely explanation, considering the results shown in Figure 7-9, is that the students felt more confident in working with conversions involving whole numbers, rather than decimals. The mean percent correct for this objective for the Grade 10 sample was 62% and for the Grade 12 group was 66%.

The results for this objective show that students are making acceptable progress in learning to work in the metric system. The results can be contrasted with the Metric usage items, in Table 77-10, where students given the choice, chose the response that involved Imperial units over the Metric units. The students appear to be learning the metric system of measurement in school; however, teachers cannot force the students to use the units outside of school.

Perimeter, Area, and Volume

This objective assessed the students' grasp of methods of calculating the perimeter, area, and volume of common two- and three-dimensional geometric figures. Two of the six items in this objective involved estimating areas and the Interpretation Panel rated the results of one item as Marginal and the other as Weak. The overall results for this objective were rated as Marginal by the Panel. The mean percent correct for the Grade 10 sample was 47% and for the Grade 12 group it was 48%.

Of the six items used in this objective, the performance was rated as Marginal or Weak for five of the items by the Interpretation Panel. There is no obvious explanation for this less than acceptable result as the items dealt with different topics and assessed students' responses to questions involving areas of circles, right triangles, squares, and rectangles. The results for two items are shown in Figure 7-10 and 7-11.

The Interpretation Panel rated the results on Item B/40 as Satisfactory which made it the highest rated item for the objective. The success rate was surprisingly high given that the problem is not a one-step volume problem.

The Interpretation Panel rated the results of Item B/21 as Weak since only 38% of Grade 12 students responded correctly. The item is illustrated in Figure 7-11.

This is another example of a multi-step problem. Students were required to recall the definition of perimeter, area, and square. The results showed that 39% of the Grade 12 group and 40% of the Grade 10 sample simply squared the number that was given in the question.

B/40. A small cube measures 2 cm by 2 cm by 2 cm. How many of be put into a rectangular box that is 24 cm long by 10 cm wide by 6 cm deep?

	% of students Gr.10	Gr.12
60	19	15
180	54	58†
720	11	8
1440	5	4
I don't know ..	12	15

Figure 7-10. Grades 10 and 12--Items B/40.

B/21. The perimeter of a square is 12 centimetres. Find the area in square centimetres.

	% of students Gr.10	Gr.12
48	14	12
9	36	38†
12	4	4
144	40	39
I don't know ..	6	8

Figure 7-11. Grades 10 and 12--Item B/21.

The overall results of this objective suggest that more attention should be given to the topics of perimeter, area, and volume by mathematics teachers. It is felt by many educators that any student graduating from secondary school should, as a minimum for this objective, understand what is meant by

and be able to calculate the area of common figures given the needed dimensions.

7.7 Domain 4: Algebraic Topics

Thirty-two items over four objectives were included in the Algebraic Topics domain: Expressions, Equations, and Inequalities; Graphs; Probability; and Statistics. Twelve of the 32 items were not part of the B. C. curriculum. The number of items, the mean percent correct, and the rating are listed by objective in Table 7-16.

Table 7-16
Grade 12: Algebraic Topics Domain

Objective	Number of Items	Mean Percent Correct	Panel Rating
Expressions, Equations and Inequalities	14	56	S
Graphs	6	74	VS
Probability	6	54	S
Statistics	6	30	W to M

The mean percent correct, for this domain, for the Grade 12 group was 54% and for the Grade 10 sample, 48%. The Interpretation Panel's overall rating, for this domain, was Satisfactory.

Expressions, Equations, and Inequalities

The 14 items chosen for this objective were designed to assess the students' ability to solve linear algebraic equations, to factor and find the roots of quadratic equations, to solve systems of linear equations, to solve linear inequalities, and to evaluate expressions.

The mean percent correct for the Grade 10 sample, for this objective, was 49% and for the Grade 12 group, 56%. The results of this objective were rated as Satisfactory by the Interpretation Panel. The Panel suggested that students performed well on straightforward items but had some difficulty with non-routine items such as solving for a variable in terms of another or working backwards through an expression.

The Interpretation Panel rated the results of nine of the 14 items for this objective as either Very Satisfactory or Satisfactory. The results of the remaining five items were rated Marginal.

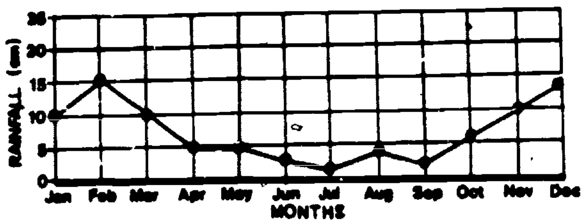
Graphs

The six items in this objective were designed to evaluate students' ability to read information and draw conclusions from data presented graphically. Only two of these items involved coordinate graphs. The other four items were the type that everyone should be able to interpret from their experiences with data presented in the daily newspapers.

The mean percent correct for the Grade 10 sample, for this objective, was 70% and for the Grade 12 group it was 74%. The Interpretation Panel rated the results for this objective as Very Satisfactory. The Panel offered the opinion that students performed well on this objective because of the pictoral presentation of the data.

One of the two items rated as Strong by the Panel is presented in Figure 7-12 The results from that item show that the students had little difficulty interpreting the graph in order to assess the question correctly.

A/1. For how many months was the rainfall more than 5 cm?



	% of students Gr.10	Gr.12
3	2	2
4	2	2
6	90	92†
7	5	4
I don't know ..	2	1

Figure 7-12. Grades 10 and 12--Item A/1.

The data show students did well on these items. The overall results, for these items, suggest that students from Grades 10 and 12 are able to interpret correctly data presented graphically. This high positive response could be due to the fact that most students encounter graphs in many other subject areas besides mathematics.

Probability

The six items in this objective were all non-curricular items and were included in this assessment for the purpose of gathering base-line data in an area of mathematics that is gaining in importance in the secondary curriculum of other provinces and countries.

The items were designed to measure whether students had acquired some of the basic notions of Probability. The mean percent correct for the Grade 10 sample was 49% and for the Grade 12 group was 54%.

The overall mean percent correct can be considered as a positive result for items that were new to most students. The Interpretation Panel rated the results of this objective as Satisfactory. The results for five of the six items were rated as Satisfactory and the results for the sixth item was rated as Marginal/Satisfactory. The Panel suggested that Item B/6 was reasonably well done considering the degree of complexity of the question. The Panel also rated the results of Item B/37 to be Satisfactory especially in view of the fact that this topic is not included in the B. C. curriculum. The results of these two items are displayed in Figure 7-13.

The most common error made in Item B/6 was in not making the distinction between, for example, a car painted with a red top and blue bottom and a car painted with a blue top and red bottom. As a result, approximately the same percent of Grade 10 and Grade 12 students chose 10 as the correct solution.

In Item B/37, almost one third of the students subtracted 0.36 from 100. One possible explanation is that the students interpreted the probability of 0.36 as being 0.36% and subtracted it from 100%. Another possible, and similar, explanation is that the students subtracted 0.36 from 1, but used 1 in the form of 100%.

Statistics

This is another objective that was included in this Assessment to obtain base-line data. Statistics is included in the B. C. mathematics curriculum as a special course, Probability and Statistics 12, and some statistics are inclu-

B/6. The roof and the body of a car are to be painted different colors. Using only 5 colors, how many different ways can the car be painted?

	% of students Gr.10	Gr.12
5	22	19
9	3	4
10	28	29
20	34	37†
I don't know ..	12	11

B/37. If the probability that it will rain on a given day is 0.36, then the probability that it will not rain is:

	% of students Gr.10	Gr.12
0.64	53	58†
0.36	7	5
99.64	31	31
99.36	1	1
I don't know ..	7	5

Figure 7-13. Grades 10 and 12--Items B/6 and B/37.

ded in courses such as Consumer Mathematics.

The six items in this objective were chosen to assess students' ability to interpret information presented in tabular form and to determine their familiarity with two measures of central tendency--the mean and the median. The mean percent correct for the Grade 10 sample, for this objective, was 23% and for the Grade 12 group was 30%.

The overall results for this objective were disappointing in view of the importance of statistics in everyday life. The

Interpretation Panel rated these results somewhere between Weak and Marginal as they felt that the major difficulty was in reading and interpreting tables, both necessary skills. The Panel was less concerned with items which involved knowing definitions such as the median of a set of numbers.

The students' performance on the three items that involved the interpretation of data presented in tabular form was less than adequate. The Interpretation Panel rated the results of Item B/35, which is illustrated in Figure 7-14, as Weak.

AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers Per Month						Total
	Jan	Feb	Mar	Apr	May	Jun	
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

B/35. How many passengers used the Fiske Airport in June?

	% of students Gr.10	% of students Gr.12
7	46	42
26	7	7
700	40	43†
2600	5	6
I don't know ..	2	2

Figure 7-14. Grades 10 and 12--Item B/35.

Eighty-five percent of the Grade 12 students, and 86% of the Grade 10 students were able to find the proper piece of information from the table. Only half of them, however, knew what that piece of information represented, that is, not 7 passengers, but 7 hundred passengers. An item that caused a notable degree of confusion is shown in Figure 7-15.

B/5. A television commercial states that 90% of the people who expressed a choice thought that Brand A was better or no different than Brand X. What percent of these people could have thought that Brand X was better or no different Brand A?

	% of students Gr.10	Gr.12
Less than 10%	49	47
up to 100%	7	10†
at most 90%	12	13
cannot tell based on the information ...	29	27
I don't know	3	3

Figure 7-15. Grades 10 and 12--Item B/5.

The Panel was very unhappy that this item was included as they felt that it was a misleading item, and the results possibly supported this view as most students misinterpreted the item. The question was included to ascertain students' ability to recognize statistically insignificant claims. The negative results suggest that some time should be spent, perhaps in Consumer Mathematics units, dealing with statistically misleading claims.

7.8 Domain 5: Computer Literacy

This domain was included in the Assessment in view of the growing importance of the role of computers in education and society as a whole. It was considered necessary to assess all students' knowledge of the role of computers in society. Six non-technical items were used to try and determine how informed the students were with respect to terms such as program and memory, what computer programmers do, and uses of computers. The essential idea was to obtain data on how computer literate the students of this province are, and not to determine whether they could read a flow chart or program a computer.

The number of items, mean percent correct, and rating for the Computer Literacy domain are presented in Table 7-17.

Table 7-17
Grade 12: Computer Literacy Domain

	Number of Items	Mean Percent Correct	Panel Rating
Computer Literacy	6	66	S to VS

The Interpretation Panel rated these results somewhere between Satisfactory and Very Satisfactory as they felt that although the items used were elementary, students seem to have some basic knowledge about the issues and roles of computers in society. The Panel felt that computer related materials enhance the critical thinking process and that further development of student skills in this area is to be encourged. They also felt that computers should continue to be made available to schools and teachers that want them, rather than making the study of computers compulsory at a given grade level. The mean percent correct for this domain, for the Grade 10 sample was 60% and for the Grade 12 group it was 66%.

7.9 Problem Solving and Consumer Mathematics

Problem solving encompasses several routine and nonroutine functions considered to be necessary in the daily lives of most people. It involves applying mathematics to the solution of real world problems. Because of the growing awareness of the value of problem solving techniques to the average ci-

tizen, the National Council of Teachers of Mathematics has recommended that mathematics curricula of the eighties should be organized around problem solving.

Consumer Mathematics involves the solution of consumer-oriented problems which is considered to be a necessary skill in order for a person to be able to function in an efficient manner in society.

The 1981 Assessment was designed, in part, to study students' results in the two important areas of Problem Solving and Consumer Mathematics. Students' performance in these two areas was not evaluated by the Interpretation Panel.

Problem Solving

Sixteen items were used to define a problem solving strand on the instruments for the Grades 10 and 12 students. The objectives and the numbers of items from those objectives that formed the problem-solving strand are found in Table 7-18.

Table 7-18
Problem Solving Items by Objective

Objective	Number of Items
Fractions and Decimals	3
Ratio, Proportion and Percent	3
Geometric Figures	1
Geometric Relationships	2
Logical Reasoning	2
Perimeter, Area and Volume	3
Probability	2

The 16 problem-solving items were given the following ratings by the Interpretation Panel: Strong--2, Very Satisfactory--2, Satisfactory--5, Marginal--4, and Weak--3. It should be remembered, however, that the Panel rated each item as a part of an objective, not as part of the problem-solving strand.

The overall performance on the problem-solving was 59% for the Grade 12 students and 55% for the Grade 10 students. The mean percent correct for both groups would increase 3% by dropping just one item, Item B/19. A discussion of Item B/19

has already been given in Section 7.4.

The performance of both groups was best on the problem-solving items from the Geometry Domain. The results from item B/13 are presented in Figure 7-16. For rather obvious reasons the Panel rated the results as Strong. Item B/13 is from objective 2.3, Logical Reasoning, which contains items that are not a part of the B. C. curriculum.

B/13. Two team captains take turns choosing players for their teams. Ellen is always chosen first. Chris is always chosen second. If Ellen and Chris are never captains, how often do they play on the same team?

	% of students Gr.10	Gr.12
always	7	6
frequently	6	4
very rarely ...	4	4
never	81	83†
I don't know ..	2	2

Figure 7-16. Grades 10 and 12--Item B/13.

An example of an item which had results which were rated Weak by the Panel was Item B/21 which was presented earlier in Figure 7-11 on page 192. A sizeable portion of the students appear to have tried to solve Item B/21 by simply squaring the number provided in the statement of the problem. The students probably recognized that the clue word, area, usually means multiply, so they did. Item B/21, however, is a multi-step problem requiring division before multiplication. The percent correct is 3% greater than in 1977.

The overall mean percent correct for the problem-solving strand for both the Grade 10 sample and the Grade 12 group is less than what is desired. More concern should be focussed on problem-solving activities in the Number and Operation Domain and the Measurement Domain.

Consumer Mathematics

The Consumer Mathematics strand consisted of 15 items. The items were predominantly from the Algebraic Topics Domain. The Consumer Mathematics items are presented in Table 7-19 by objective.

Table 7-19
Consumer Mathematics Items by Objective

Objective	Number of Items
Computation with Fractions and Decimals	3
Ratio, Proportions and Percent	1
Metric Units	1
Expressions, Equations and Inequalities	2
Graphs	4
Statistics	4

The Interpretation Panel gave the following ratings to the 15 items in the Consumer Mathematics strand: Strong--2, Very Satisfactory--1, Satisfactory--3, Marginal--3, Weak--6. As with the Problem Solving strand, the items in the Consumer Mathematics strand were rated by the Panel as part of the corresponding objectives, not as part of the Consumer Mathematics strand.

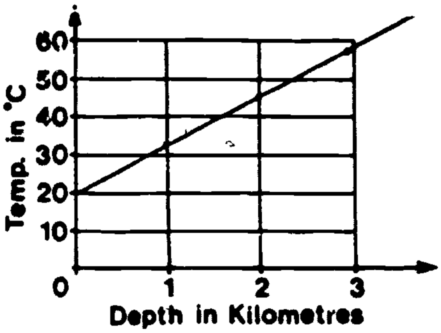
The three highest-rated Consumer Mathematics items were from the objective Graphs. Item B/1, one of the items which had results rated Strong, is presented in Figure 7-17.

The students had little difficulty in reading and interpreting the graph. The result is even more impressive when one considers that the students had to make an estimate as to the location of 2.5 km, only 2 km and 3 km are on the axis.

Three of the four Consumer Mathematics items from the Statistics objective had results that were rated Weak by the Panel. An example of one such item, B/35, was presented earlier in Figure 7-14.

In the overall performance on the Consumer Mathematics strand there were bright spots such as the performance on the graphing items, but the general performance level was less than desired.

B/1. From the graph below, the temperature at a depth of 2.5 km is closest to:



	% of students Gr.10	Gr.12
30°C	6	4
40°C	4	3
50°C	84	88†
60°C	4	3
I don't know ..	2	2

Figure 7-17. Grades 10 and 12--Item B/1.

7.10 Changes in Achievement Since 1977

A major objective of the 1981 Mathematics Assessment was to describe changes in students' achievement since the 1977 Assessment. For this purpose, a total of 29 items were repeated from the 1977 Assessment, and they were distributed over three Change Categories. The Change Categories were: Number and Operation, Geometry and Measurement, and Algebraic Topics. The results for each change item in each Change Category will be presented in this section along with an analysis of the change.

Number and Operation

The results for the 10 items in the Number and Operation change category are presented in Table 7-20.

The mean percent correct for these items in the 1977 Assessment was 65 as compared to 67 for the present Assessment. The overall positive change is considered to be satisfactory; however, some items deserve closer attention.

The two items for operations with decimals and fractions showed positive improvement which possibly indicates that, in spite of a perceived increase in dependency on calculators, students' skills in these areas have improved.

The two items involving calculations of unit price and commission showed a decrease in performance levels since the 1977 Assessment. This result is somewhat surprising due to the

Table 7-20
Grade 12: Number and Operation Change Category
(Percent)

Item Number (1981)	Topic	Results 1977	Results 1981	Change
A/6	Scientific Notation	67	66	-1
A/8	Division of Fractions	74	77	[illegible]
A/22	Division of Decimals	66	72	+6
A/24	Percent to Decimal	65	80	+15
A/30	Order of Operation	66	71	+5
B/9	Fraction to Percent	79	77	-2
B/11	Fractions	51	52	+1
B/15	Unit Pricing	65	59	-6
B/34	Order of Fractions	59	57	-2
B/45	Percent Commission	62	58	-4
Average Change				+1.5

emphasis placed on certain topics in Consumer Mathematics in the curriculum since 1977. It appears that students are learning more consumer arithmetic but understanding the applications less.

Geometry and Measurement

The results of the nine items repeated from the 1977 Assessment in the Geometry and Measurement Change Category are listed in Table 7-21.

The mean percent correct for these items in the 1977 Assessment was 57% and in this present Mathematics Assessment the mean percent correct is 61% which is an improvement of 4% in the average performance.

Though the overall change in this category is positive, the items for mass and length account for most of the improvement.

The metric change items involving mass and length showed dramatic improvement in performance with positive changes of 14% and 22%, respectively. Given that mass and length, in metric terms, have been taught in the schools for almost 10 year, the results are pleasing, but not surprising. The Grade 12 student population appears to be learning the metric system of measurement in school, but the results on the metric usage items show that this knowledge is not being used in everyday situations. On the other hand, the performance on the geometry items remained unchanged.

Table 7-21
Grade 12: Geometry and Measurement Change Category
(Percent)

Item Number	Topic	Results 1977	1981	Change
A/13	Mass	54	68	+14
A/23	Area of Rectangle	54	56	+2
A/26	Diameter	78	81	+3
A/32	Area of Triangle	54	49	-5
B/12	Length	63	85	+22
B/21	Perimeter and Area	35	38	+3
B/26	Obtuse Angle	62	54	-8
B/32	Area of Circle	72	74	+2
B/43	Theorem of Pythagoras	43	49	+6
Average Change				+4.3

Algebraic Topics

The results of the 10 items included in the Algebraic Topics change category are presented in Table 7-22. The mean percent correct for these items in 1977 was 59% and in 1981, 59%. The results show that the mean percent correct for this topic is virtually unchanged from the 1977 Assessment.

Table 7-22
Grade 12: Comparison of the Results on the Items (Percent Correct) in the Algebraic Topics Change Category

Item Number	Topic	Results 1977	1981	Change
A/34	Slope of a Line	43	42	-1
A/39	Factoring	61	64	+3
A/41	System of Equations	63	59	-4
A/44	Interpreting Graphs	67	75	+8
A/45	Formula Application	62	64	+2
B/30	Coordinates of a Point	72	76	+4
B/38	Simplifying Expressions	44	44	0
B/39	Roots of Equations	60	56	-4
B/42	Formula Manipulation	48	44	-4
B/44	Writing Equations	70	64	-6
Average Change				-0.2

The greatest decline shown in this Change Category was with the item involving equation writing, which showed a decline of 6% from 1977. Other items involving roots of equations, systems of equations, and formula manipulation all showed negative change. The items that involved coordinates, graphs, formula application, and factoring all showed positive change.

The overall results of the three Change Categories indicate improvement in basic skills since 1977. The results of items involving operations with fractions and decimals, measurement, factoring, coordinates of points, and interpretation of graphs all show more positive results at this time. As noted previously, the items involving area of a triangle, unit pricing, and percent commission showed some decline in results from the 1977 Assessment. Overall 16 change items showed a gain (one item showed no change); the average was about 6%. Twelve change items showed a decline; the average decline was about 4%.

7.11 Reporting Categories

Achievement in the study of mathematics is the result of several factors, both external and internal. The basic ability of the student, the home environment, the curriculum, teacher expectations, and peer pressure are all factors that contribute to the performance of the student. A large amount of data regarding the relationship between background variables and achievement could have been gathered in this present Assessment. From this large number of variables, a smaller set was selected and the relationship of these factors to performance was studied. The results presented in the present assessment do not represent cause-and-effect relationships. They do show that certain factors that are thought to influence outcomes occur at the same time.

In the sections that follow, the results reported are based upon correlational trends. They are taken from a random sample of 10% of the original Grade 12 Assessment population whose last mathematics course was either Mathematics 10, Algebra 11, or Algebra 12. The sample was chosen in this way so that the results of the largest category of Grade 12 students, students taking academically-oriented mathematics courses, could be reported. The random sample was comprised of 764 Grade 12 students whose last mathematics course was mathematics 10, 677 whose last course was Algebra 11, and 938 Algebra 12 students. There were 1195 male and 1184 female students included in the sample for a total of 2379.

Mathematics Background

One goal of the present Assessment was to obtain data on students' mastery of certain areas of the mathematics curriculum. This mastery is, to a great extent, a function of the number of years that the students have studied mathematics and the level of the last mathematics course taken.

The data in Figure 7-18 illustrate the comparison of students' performance as a function of their mathematics background. The results are presented for four groups of students. Those students who were in Grade 12 and whose last mathematics course was Algebra 12, students in Grade 12 whose last course was Algebra 11, students in Grade 12 who completed Mathematics 10 as their last mathematics course, and students currently enrolled in Grade 10. The results for all five domains of the Assessment are shown on the graph.

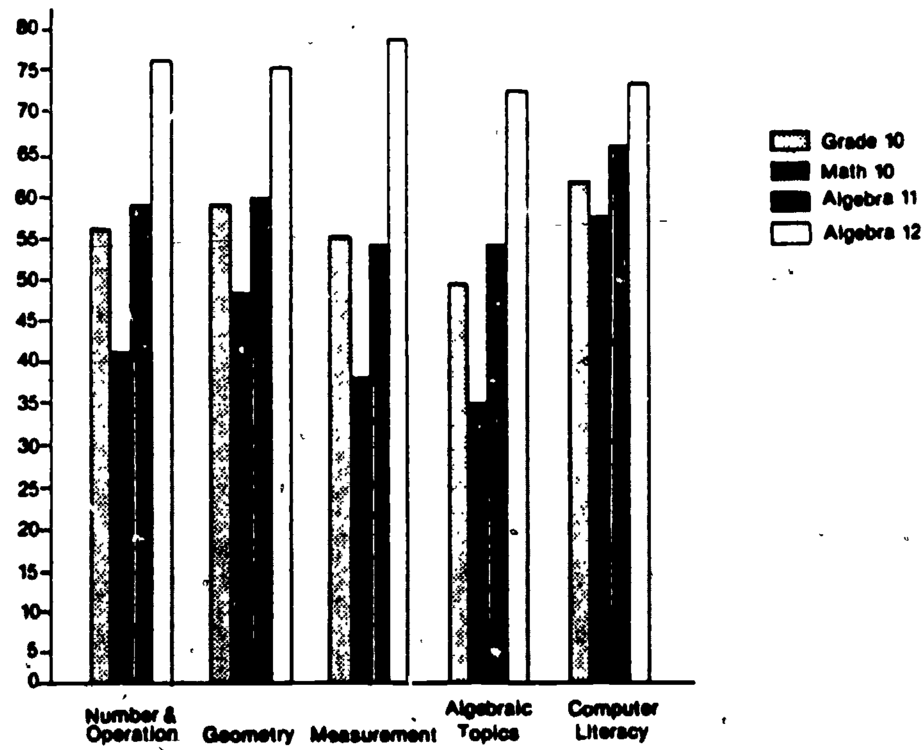


Figure 7-18. Grades 10 and 12--Achievement by mathematics background.

The Mathematics 10 group's performance is lowest for all domains. The least satisfactory results for this group are in the Measurement domain and the Algebraic Topics domain. The Algebra 12 group, as expected, performed satisfactorily over all domains with the best results shown in Domain 3, Measurement.

The Mathematics 10 group has shown no real improvement in performance since the 1977 Mathematics Assessment, and steps must be taken to improve the mathematical competencies of this group. It is becoming more evident that Grade 11 mathematics should be made mandatory for all students in the province, if a satisfactory level of mathematical competency is to be attained by all secondary school graduates.

Sex Differences

As was the case in the 1977 Mathematics Assessment, male students outperformed females in all three groups of the sample under consideration, and over all objectives in this present Assessment. The only exception was the Algebra 12 group for the objective Logical Reasoning. The results are displayed in the graph in Figure 7-19.

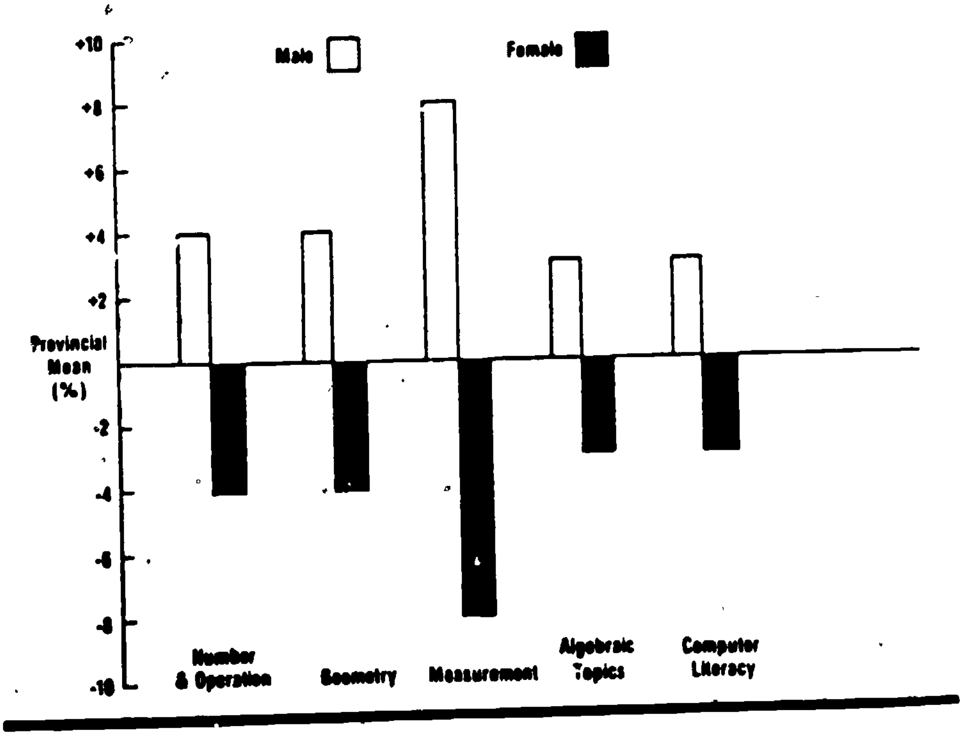


Figure 7-19. Grade 12--Sex differences in achievement.

The results showed another similar pattern to the results obtained in the 1977 Mathematics Assessment. At the domain level, when mathematics background is controlled, the same differences occur in the male/female comparisons on achievement. The difference between achievement of males and females were least with the Algebra 12 students; on two of the five domains the difference were greatest for the mathematics 10 group.

Future Plans

The results for the five domains organized by future plans are presented in Figure 7-20. The category designated Training includes students who planned to proceed to business, vocational, art, or trade school, or to attend a technical institute's or community college's career program. The designation University includes all students who planned to go to university or attend a community college's university transfer program.

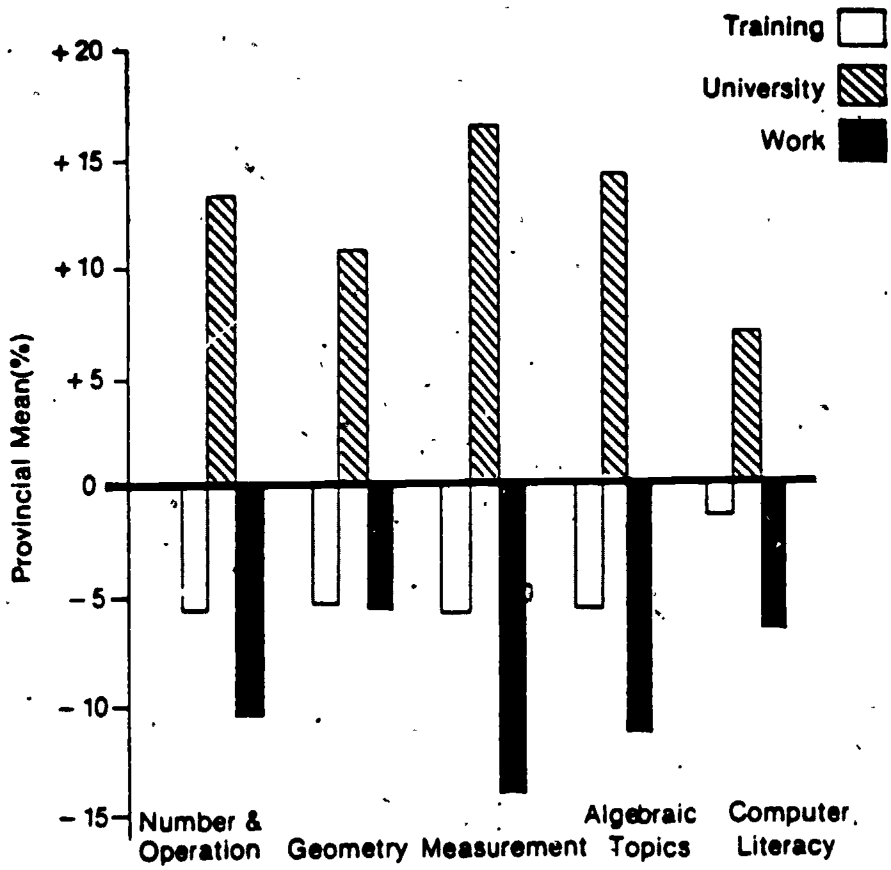


Figure 7-20. Grade 12--Achievement by future plans.

Not surprisingly, the university group's performance was best for all domains. The differential in performance between the Job and University groups was over 25% on the Measurement domain and the Algebraic Topics domain, and over 20% for the Number and Operation domain. It is worth noting that the domain on which the results were most closely grouped (range of 14%) was Computer Literacy, the domain whose items did not come from the B. C. curriculum. The Training group outperformed the Job group on all five domains though by a very slight margin in the Geometry domain.

7.12 Summary

The Grade's 10 and 12 achievement instruments, which were identical, consisted of two booklets, each with 45 achievement items, 18 background information items, and 19 items in a section entitled "Mathematics and Myself". Students were given either Booklet A or Booklet B from which the items were designed to assess the students' mastery of 13 objectives over five domains.

A total of 29 achievement items were repeated from the 1977 Mathematics Assessment for the purpose of measuring change. In addition, four non-curricular topics were assessed--Computer Literacy, Probability, Statistics, and Logical Reasoning.

Forty-five minutes were allotted for instructions and for the distribution, completion, and collection of each booklet. All achievememt items were of the multiple choice type. For each item, five possible responses were given. Of these, four were possible answers to the item and the fifth was "I don't know".

The Grade 12 instrument was designed to be written by students enrolled in Grade 12, regardless of their mathematical backgrounds. There was a total of 24 466 students who participated at this level. The Grade 10 instrument was written by a sample of 2456 students currently enrolled in Grade 10.

Background Information

Based on the data gathered from the 18 background information items, both samples (Grades 10 and 12) were fairly evenly divided between males and females. Over 90% of the Grade 12 students were either 17 or 18 years old, whereas 94% of the Grade 10 group was 16 years old or younger. In addition, for 92% of the students that participated at the Grade 10 and 12 levels, English was the language spoken in the home. An examination of mathematics background by sex showed that, for the Grade 12 group, 42% of the students enrolled in Algebra 12 were female as compared with 49% in Algebra 11, 60% in Consumer Mathematics 11 and 12% in Trades Mathematics 11.

The three questions on the instrument concerning the use of calculators were identical to the questions asked on the 1977 Mathematics Assessment. A plurality of Grade 12 students and Grade 10 students use calculators at home, for homework, and in school. The responses to these questions indicate a greater number of students using calculators presently than was the case in 1977.

Students were asked three questions concerning the use of computers in their schools. A majority of students have computers in their school. A majority of the students who had taken a class in which a computer was used used a computer in one of their mathematics classes or a computer science class.

A majority of the students at both the Grades 10 and 12 levels works between 10 and 20 hours a week at part-time jobs. Over 60% of the Grade 12 group plan to enroll in a post-secondary institution after graduation.

Students were given four questions involving metric usage. They were asked to choose the response which more readily came to mind from two responses, one in metric units, the other in imperial units, but both correct. The results of the items involving four types of metric units, show that the students were more familiar with the metric temperature unit. The results also show that the majority of Grade 12 students select the Imperial unit response when given a choice.

There were 19 items designed to measure the students' attitudes toward mathematics. The results show that 41% of the Grade 12 students have a positive attitude toward mathematics compared to only 18% who have a negative attitude.

Achievement

The 90 achievement items on the two forms of the Assessment were organized in five domains, which were divided into 13 objectives. The items were also categorized by cognitive level. There were 40 items at the Knowledge level, 22 at the Comprehension level, and 28 at the Application level.

Number and Operation. The results for the items involving number concepts were rated as Marginal by the Interpretation Panel, and all questions involving estimation were rated as less than satisfactory. Students require more pracitce with estimation questions in view of the increased use of the calculator at all levels. The results of Operations with Fractions were also rated as Marginal, whereas students' responses to questions involving percentage was rated as Satisfactory, and questions on ratio as less than satisfactory.

Geometry. Questions involving geometric figures were rated as Satisfactory, whereas those involving geometric relationships were rated between Marginal and Satisfactory. The responses to the non-curricular objective, Logical Reasoning, were rated as Very Satisfactory.

Measurement. Though the performances were rated as Satisfactory for items involving metric measurement, the three

items concerning conversion within the metric system were rated as Weak. Performance on the items involving area and volume were rated as Marginal.

Algebraic Topics. The results on the items involving equations, graphs, and probability were rated from Satisfactory to Very Satisfactory. The results on the items involving statistics were rated between Weak and Marginal.

The results for items involving factoring, the solution sets of equations, and the solution of inequalities were regarded as very favorable. Questions that required interpretation of data from graphs were done exceedingly well by a large majority of the students. Students responded less than satisfactorily to items that required reading data from tables.

Computer Literacy. The results of the items under this domain were rated between Satisfactory and Very Satisfactory. Students appear to have a good understanding of the purpose and function of computers in society.

Problem Solving and Consumer Mathematics. The success rate for the 16 items for problem solving was 59%, an acceptable performance. It is interesting to note that the Grade 10 sample had a higher success rate than two of the three Grade 12 sub-groups. The same pattern held for Consumer Mathematics. The success rate for the 15 items for Consumer Mathematics was 55% with the Grade 10 sample scoring higher than two of the three Grade 12 sub-groups.

Changes in Achievement Since 1977

The 29 items in common to the 1977 and 1981 assessements were organized into three Change Categories. The Change Categories were Number and Operation, Geometry and Measurement, and Algebraic Topics.

Contrary to the past pattern in mathematics assessment in other places, there were no declines in achievement at the domain level. The present performance of the Grade 12 students for the Number and Operation category was 1% better than the performance of students in the 1977 Mathematics Assessment. Over the Geometry and Measurement category, there was a 5% increase in performance over the 1977 Mathematics Assessment, and for the Algebraic Topics category there was no change.

The results on a number of items such as metric measurement, order of operation, division of decimals, and changing a percent to a decimal showed marked improvement over the 1977 Assessment results. However, the results of some items such as unit pricing, percent commission, and areas of triangles

showed a decline in performance. The three most noticeable changes in performance since 1977, were all positive changes of at least 14%.

Reporting Categories

The Grade 12 data for the Mathematics Background items were taken from a sample of 10% of the Assessment population whose last mathematics course was either Mathematics 10, Algebra 11, or Algebra 12.

The results for the Mathematics Background category were identical to the results of the 1977 Assessment. The Algebra 12 group performed at a much higher level than the Algebra 11 or Mathematics 10 groups; A not surprising result since the Algebra 12 group had taken a mathematics course for every year of their school career. The Algebra 11 group, as would be expected, outperformed the Mathematics 10 group over all domains.

Male students outperformed female students on all objectives. Students who planned to attend university after graduation outperformed, by a considerable margin, students who planned on more vocational training or planned to look for a job.

CHAPTER 8

THE TEACHERS OF MATHEMATICS

James M. Sherrill and David F. Robitaille

As in 1977, two questionnaires were developed for the 1981 Mathematics Assessment. One questionnaire was completed by elementary school teachers and the other by secondary school teachers. The sample of elementary teachers was drawn from the population of teachers who had submitted a Form J[1] to the Ministry of Education in September 1980 and who had registered at least one class of Grades 1 - 7. Teachers who were also serving as district level personnel were excluded. The sample of secondary teachers was drawn from the population of teachers who submitted a Form J to the Ministry of Education in September 1980 and who had registered at least one mathematics class in Grades 8 - 12. Again, teachers who were serving as district level personnel were excluded.

A teacher could qualify for participation in several ways: an elementary teacher might have a split Grades 4/5 class, for example, and would be entered as both a Grade 4 teacher and a Grade 5 teacher; a secondary mathematics teacher might be teaching a Grade 8 mathematics class, a Grade 9 mathematics class, and a Grade 10 mathematics class and would be entered as a teacher at each of those levels. Using a probabilistic model each teacher was assigned to one and only one grade level. It is interesting to note, however, that 31% of the elementary teachers indicated that they taught more than one mathematics class.

The population was then stratified by grade level. The number of returned questionnaires needed to attain accurate data was calculated, and the number of questionnaires to be sent out in order to receive the required number of returns was determined.

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[1]Form J, "Teacher's Report on Qualifications, Salary, Experience, and Class Size", is completed by teachers in B. C. each September.

The teachers to whom the questionnaires were to be sent were randomly selected. The selection was accomplished by randomly selecting a starting point on the list of eligible teachers and then selecting every nth teacher, where n was determined by dividing the number of teachers on the list by the number of questionnaires needed to be sent out in order to obtain accurate data.

One thousand one hundred sixty-five elementary questionnaires were mailed and 868 returned completed for a return rate of 75%; 951 secondary questionnaires were mailed and 733 returned completed for a return rate of 77%. Given that the questionnaires were about thirty pages long, required a lot of time and effort to complete, and were distributed by mail, the return rates are very good.[2]

These high return rates are a good indication of not only the dedication of B. C. teachers but of their willingness to go beyond the call of duty to help improve the teaching of mathematics. They deserve to be congratulated.

8.1 Structure of the Questionnaire

Although separate questionnaires were prepared for the elementary and secondary levels, they shared the same structure and many similar items. Of the seventy items on the elementary questionnaire and the sixty-seven items on the secondary questionnaire, sixty-four items appeared on both.

Each questionnaire consisted of eight sections: A--Teacher Background, B--Goals of Mathematics Education, C--Program Implementation, D--Calculator and Computer Use, E--Assessment and Testing, F--Mathematics Teacher Education of the Future, G--Teacher In-service Education, and H--Class-Specific Information.

Though some of the items from the 1977 questionnaires were included on the 1981 questionnaires, there was more emphasis in 1981 on gathering data to assist in the process of curriculum review and revision. On the 1981 questionnaires, there were items where teachers rated general and specific goals of mathematics education, there was an entire section on

[2]In a recent National Council of Teachers of Mathematics project, Priorities in School Mathematics, which also mailed two types ofquestionnaires, return rates averaged 29% and 34%.

implementing a mathematics program, there was a section where the teachers could give some indication of how they felt teacher education should be accomplished, and there was a section on the in-service education of teachers.

Some items were used to define mathematics curriculum models. Teachers supporting the models were identified, and the results of the teachers supporting the different models were compared.

The results of the survey are divided in two parts and are presented in Chapters 8 and 9. In Chapter 8 the results from sections A, B, F, and G are presented; Chapter 9 contains the results from sections C, D, E, and H.

The validity of data collected through questionnaires is always open to question. On items dealing with questions of fact, there is usually no problem; however, when opinions are sought, two factors may affect results. On the one hand some respondents may feel that a particular response is wanted by those who are gathering the data and will slant their response in the perceived direction. On the other hand, the other factor is the "Screw You" effect[3], that is, some respondents may feel a particular response is wanted by those who are gathering the data and will slant their response in the opposite direction. The high return rates, however, mean the responses are representative of the entire population of B. C. teachers which makes the probability of those two factors significantly biasing the data very low. High return rates are also a good indication that the respondents have taken the task seriously.

There are two restrictions that should be placed on the interpretations made of the data gathered by a questionnaire. The first is that the respondent may not define some particular term the same way that either the researcher or other respondents do. For example, Logical Thinking does not appear as a topic in the curriculum until the secondary level, yet 80% of the elementary teachers responded that Logical Thinking was currently being emphasized in Grades 1-7. It is not known what definition of Logical Thinking the elementary teachers were using, but it is likely that the definition was different

[3]Barber, T. X. "Pitfalls in Research, Nine Investigator and Experimenter Effects" in Second Handbook of Research on Teaching, R. M. W. Travers (Ed.). Chicago: Rand McNally and Company and the American Educational Research Association, 1973, p. 399.

from the one used in the curriculum.

The second restriction is that the items are not open-ended. In planning the ideal teacher education program, for example, the teachers were not asked to present their own program, but to respond to a specific list of choices. A different list of choices could change the results.

The two restrictions on the interpretations made of data gathered by questionnaires were addressed while the questionnaires were being developed. Teachers at all levels were involved in earlier forms of the questionnaires and their comments were used in the selection of items, wording of items, and the list of choices for items. In addition, several of the items were taken from the Goals Survey Questionnaire. An attempt was always made to use the most unambiguous terms possible and to present complete lists of choices with the items.

8.2 Part A--Teacher Background

The initial section of the questionnaires, Teacher Background, contained items concerning years of teaching, teaching load, academic and professional preparation, membership in professional associations, and teaching preferences. In addition, elementary teachers were asked about the type of classroom situation in which they taught.

The average teacher of elementary school mathematics is an experienced teacher teaching mathematics in a self-contained classroom. Seventy percent of the teachers have taught for six or more years and 40% have taught for eleven or more years. Ninety percent are teaching in self-contained classrooms and mathematics represents less than 25% of the teaching load of 84% of elementary teachers.

Seventy-two percent of the elementary teachers feel that the mathematics content courses they have taken adequately prepared them to teach mathematics; 70% feel the same way about their mathematics methods courses and 66% feel that way about their other education courses. Sixteen percent of the elementary teachers have never successfully completed a post-secondary mathematics course, and 13% have never successfully completed a course in the teaching of mathematics.

The average teacher of secondary school mathematics is an experienced teacher, but not necessarily a full-time mathematics teacher. Sixty-four percent of them have taught for six or more years, and 41% have taught for eleven or more years. One disturbing result is that mathematics represents less than

half of the workload of 47% of the teachers teaching mathematics. Given that teachers would have to be teaching eight classes before two mathematics classes would represent 0 - 25% of their teaching load, it may be assumed that 30% of the teachers teach only one class of mathematics.

Eighty percent of the secondary teachers feel that the mathematics content courses they have taken adequately prepared them to teach mathematics; 62% feel the same way about their mathematics methods courses and 60% feel that way about their other education courses. However, 10% of the teachers have never successfully completed a post-secondary mathematics content course. Even more disturbing is the fact that 28% have never successfully completed a course in how to teach mathematics. In other words, a significant number of teachers of secondary school mathematics have inadequate academic or professional preparation

Very few elementary teachers belong to any of the professional associations that were listed in the questionnaire. Only 1%[4] belong to the B. C. Association of Mathematics Teachers (BCAMT) and the same proportion belong to the National Council of Teachers of Mathematics (NCTM). Thus at most 2% of elementary teachers belong to either of the two professional associations for teachers of mathematics that are most readily available to them. The membership in the two general professional associations for elementary teachers is also low with 15% belonging to the Provincial Intermediate Teachers Association and 28% belonging to the B. C. Primary Teachers Association.

Very few of the secondary mathematics teachers belong to the two professional associations specifically designed for mathematics teachers. Only 26% belong to the BCAMT and 14% to the NCTM.

In the 1977 B. C. Mathematics Assessment <u>Instructional Practices</u> report (Robitaille and Sherrill, 1977), there was a recommendation concerning membership in professional associations. Based on the results for both elementary teachers and secondary mathematics teachers, a recommendation concerning membership in professional associations is again needed. Elementary teachers cannot be expected to pay for membership in all the content-oriented associations (mathematics, social studies, physical education, etc.). The BCAMT may want to contact the other content-oriented profes-

[4]Down from 3% in 1977.

sional associations in B. C. to create a "blanket" membership that would cost substantially less than the total cost of joining each of the associations separately. The BCAMT may also want to encourage schools to subscribe to <u>Vector</u>.

About 70% of elementary teachers and 75% of secondary teachers have attended a mathematics session at a conference, a workshop, or an in-service day in mathematics in the last three years. One interesting finding in the data concerning who attends the mathematics sessions was that over two thirds of the elementary teachers and almost three fourths of the secondary teachers who said they had attended a mathematics session at a conference in the last three years were also the ones who responded that they had attended a workshop or in-service day in mathematics in the last three years. On the other hand, 61% of the elementary teachers and 63% of the secondary teachers who responded that they had not attended a mathematics session at a conference in the last three years also had not attended a mathematics workshop or in-service program in the last three years. In general, the teachers who attend the workshops and in-service programs in mathematics are the same teachers who attend the mathematics sessions at conferences.

Overall, the teachers indicated that they enjoyed teaching at their respective levels and teaching mathematics. Over 90% of the teachers responded that if they had a choice of any level, they would prefer to teach at their current level. Almost 94% of the teachers also responded that if they had a choice, they would continue to teach mathematics.

8.3 <u>Noteworthy Sub-Populations</u>

Results from both questionnaires indicate that there exists a group of teachers who feel that they were not adequately prepared to teach mathematics. In addition, at the secondary level, there appears to be a group of teachers for whom mathematics represents at most only one fourth of their teaching load. In each case the responses of these sub-groups were compared to the remainder of the sample of teachers.

<u>Inadequately Prepared Teachers</u>

The teachers who considered themselves to be inadequately prepared to teach mathematics represented 19% of elementary teachers and 16% of secondary teachers. All teachers were asked to rate how well their mathematics content courses, their mathematics methods courses, and their other education courses had prepared them to teach mathematics. If a teacher

selected Inadequately for all three types of courses or selected Inadequately for two types of courses and Adequately for the third, then the teacher was classified as an Inadequately Prepared Teacher.

The data from the Teacher Background and Program Implementation sections of the questionnaire indicate that a significantly lower proportion of the Inadequately Prepared secondary teachers, in comparison to the rest of the secondary teachers, had attended a mathematics session at a conference, or a mathematics workshop, or an in-service program in the last three years. A significantly lower proportion of Inadequately Prepared teachers had referred to the curriculum guide recently. Compared to the rest of the teachers a higher proportion of the Inadequately Prepared secondary teachers preferred to teach at the junior secondary rather than the senior secondary level.

In preparing the ideal teacher education program, a lower proportion of the Inadequately Prepared secondary teachers considered mathematics courses from the department of mathematics and foundation courses in education Essential. Each of the following was also given an Important or Essential rating by a lower proportion of the Inadequately Prepared secondary teachers: techniques of classroom management and discipline, techniques of evaluation, and teaching algebra. A lower proportion of the Inadequately Prepared secondary teachers felt that algebraic concepts and skills and consumer mathematics should receive much emphasis in the curriculum. In addition, a lower proportion of the Inadequately Prepared elementary teachers felt that mathematics content from the Faculty of Education were Important or Essential in their ideal teacher education program.

With respect to professional development through in-service education, a lower proportion of the Inadequately Prepared secondary teachers had had experience with each of the nine groups listed. A majority of the Inadequately Prepared secondary teachers had had no experience with seven of the nine in-service groups listed. A lower proportion of the Inadequately Prepared secondary teachers responded to a positive category for each of the nine in-service groups listed.

Part Time Mathematics Teachers

The data from the Teacher Background section of the secondary teachers' questionnaire indicate that, for almost half of the secondary teachers teaching mathematics, mathematics does not represent a majority of their teaching load. Based on the questionnaire data and the possible number of classes a teacher can teach, it appears that 30% of the teachers sur-

veyed teach only one class of mathematics. An analysis was made of the responses from the teachers teaching only one mathematics class, Single Mathematics Class teachers.

Other data from the Teacher Background section of the questionnaire indicate that 23% of the Single Mathematics Class teachers have not completed a post-secondary mathematics class, and a majority have not completed a course in how to teach mathematics. In both cases the proportion is much higher than for teachers whose teaching is predominantly mathematics. Only 29% of the Single Mathematics Class teachers have attended a mathematics session at a conference, and 32% have attended a mathematics workshop or in-service program in the last three years. Both of these percentages are much lower than the comparable ones for teachers whose teaching load is predominantly mathematics.

Since mathematics is probably not their teaching specialty, and certainly not their main workload responsibility, it is not surprising that only about one fourth of Single Mathematics Class teachers had read any of the Assessment reports concerning the student results. The Instructional Practices report, for example, discusses how teachers teach mathematics, and only 6% of Single Mathematics Class teachers had read it.

Seventy-seven percent of the Single Mathematics Class teachers are teaching a required mathematics class, that is, a Grade 8, 9, or 10 mathematics class. An additional 15% are teaching a non-academic Grade 11 mathematics class.

In the Class-Specific Information section of the questionnaire, the data indicate that over twice the proportion of Single Mathematics Class teachers as teachers for whom mathematics represents a majority of their teaching load have their students engage Frequently or Very Frequently in Drill on arithmetic computation. Almost half of the Single Mathematics Class teachers do not allow their students to use calculators in their mathematics class compared to about 30% of the teachers for whom mathematics representsa majority of their teaching load.

8.4 Part B--Goals of Mathematics Education

Both elementary and secondary teachers were asked to rate the importance of eight overall goals of school mathematics. The first seven of the eight goals were identical to those on the Goals Survey. The teachers rated each goal using the descriptors Not Important, Somewhat Important, Important, and Essential. The results are presented in Table 8-1.

Table 8-1
Ratings of Overall Goals for School Mathematics
(Percent)

Goal	Important or Essential	
	Elementary*	Secondary
1. To teach students the mathematical concepts and skills required to function as enlightened consumers in a technological society	95	93
2. To serve as a mechanism for sorting students for entrance into their vocational fields of interest	34	38
3. To familiarize students with the major ideas and processes used in mathematics	86	78
4. To prepare students for entry into specialized technological, scientific, and professional fields	64	77
5. To develop in students the ability to think logically	94	90
6. To develop students' interest in and enthusiasm for the study of mathematics by introducing them to interesting mathematical topics	80	63
7. To prepare students for the study of further mathematics	66	69
8. To develop the idea that mathematics is the science of abstract, deductive structures	26	23

*Percent of teachers rating the goal as either Important or Essential

Both groups of teachers agreed with the Review Panels that the two most important goals were to prepare students to live in society and to develop students' ability to think logically. Both were rated Important or Essential by over 90% of the teachers.

While these two goals were rated highest by the teachers, at least 63% of each group of teachers rated six of the eight

goals as Important or Essential. On the otherhand, at most 38% of either group rated the two goals of sorting students into vocational fields or of developing mathematics as the science of abstract structures as Important or Essential.

The two groups were in substantial agreement on their ratings of six of the eight goals. They differed by 13% on the importance of preparing students for entry into specialized fields and 17% on the importance of developing student interest in and enthusiasm for mathematics. In the first case, secondary teachers felt the goal was more important than their elementary counterparts; in the second case, the reverse was true.

8.5 Part F--Mathematics Teacher Education of the Future

In this section of the questionnaire, teachers were given an opportunity to design an ideal program for the preparation of teachers of mathematics for the 1980s. They were asked to rate the importance that different general components, different mathematical content areas, and different disciplines would play in their ideal teacher education program and the importance of preparation in different teaching methods and areas of content.

First, teachers were asked to rate the importance that certain types of courses would have in their teacher education program for teachers of school mathematics for the 1980s. The results are presented in Table 8-2.

Both groups of teachers were in agreement on which three components were most important. They both rated very highly those areas that were related most closely to the teaching experience. Secondary teachers also rated highly mathematics courses from the department of mathematics whereas only 46% of the elementary teachers rated such courses as Important or Essential. Though a majority of both groups rated mathematics content courses from the Faculty of Education as Important or Essential, a substantially greater proportion of elementary teachers than secondary teachers did so.

The only course area outside of the Faculty of Education to be rated as Important or Essential by a majority of elementary teachers was English. Neither content courses in other disciplines nor foundations courses in education were rated as Important or Essential by more than 36% of either group of teachers. As a matter of fact, courses in educational foundations were rated as Not Important by 27% of the teachers.

Next, the teachers were asked to rate specific teaching areas or skills with respect to how important each would be in

Table 8-2
Components of an Ideal Teacher Education Program
(Percent)

Course Areas	Important or Essential	
	Elementary*	Secondary
1. Mathematics courses from the department of mathematics	46	85
2. Mathematics content courses from the Faculty of Education	73	57
3. Methods of teaching mathematics	97	86
4. Content courses in other disciplines (e.g., commerce, geography, etc.)	27	36
5. Foundations courses in education (e.g., philosophy, psychology, sociology, etc.)	35	25
6. Content courses in English	52	49
7. General teaching skills (e.g., classroom management, measurement and evaluation, questioning techniques, etc.)	96	90
8. Student teaching	94	94

*Percent of teachers rating the course area as Important or Essential.

their ideal teacher education program. Though both groups of teachers were presented a list of 12 specific teaching areas or skills the two lists were not identical; however, seven of the items were the same. A summary of the ratings is presented in Table 8-3.

While only 46% of elementary teachers rated Use of Stations and Laboratories as Important or Essential, and only 24% rated Teaching Fingermath as Important or Essential, the other 10 items on the list were rated as Important or Essential by at least 68% of elementary teachers. All but one of the items received positive support from a majority of secondary mathematics teachers and that one item received positive support from 49% of secondary teachers. It is surprising that a technique such as using stations and

Table 8-3
Importance of Specific Areas
(Percent)

Areas of Teaching	Important or Essential	
	Elementary*	Secondary
1. teaching algebra	**	95
2. teaching applications of mathematics	89	89
3. teaching consumer mathematics	*	86
4. teaching decimals	79	**
5. teaching fingermath	24	**
6. teaching the four basic operations with whole numbers	98	**
7. teaching fractions	77	**
8. teaching geometry	69	84
9. teaching metric measurement	94	69
10. teaching probability and statistics	**	48
11. teaching problem solving	98	96
12. teaching the structure of mathematics	71	50
13. teaching trade and industrial mathematics	**	67
14. techniques of classroom management and discipline	92	89
15. techniques of diagnosis and remediation	95	89
16. techniques of evaluation	**	86
17. use of stations and laboratories	46	**

*Percent of teachers rating each specific teaching area or skill as Important or Essential.
**The teaching area or skill appeared only on the other list.

laboratories received so little support, relative to the others.

Six areas were rated Important or Essential by 90% or more of elementary teachers and eight Important or Essential by at least 85% of secondary teachers. About 90% of both groups rated each of the following Important or Essential: teaching problem solving , techniques of diagnosis and remediation, techniques of classroom management and discipline, and teaching applications of mathematics. Elementary teachers also gave a very positive response to teaching the four basic operations with whole numbers, which did not appear on the secondary teachers' list, and teaching metric measurement, which was highly rated by 94% of elementary teachers and by only 69% of secondary teachers. In addition to the four items rated highly by both groups, the secondary teachers also gave

a very positive response to teaching algebra, teaching consumer mathematics, and techniques of evaluation, none of which appeared on the elementary teachers' list. Eighty-five percent of secondary teachers rated training in the teaching of geometry as Important or Essential compared to 68% of elementary teachers.

After rating course and teaching areas, teachers were asked to rate specific content areas. Teachers were asked to rate the importance of eight mathematics content areas and eleven content areas in disciplines other than mathematics and education. The teachers rated each with respect to its importance in their proposed teacher education program. The percent of each group of teachers rating each mathematics content area as Important or Essential is provided in Figure 8-1.

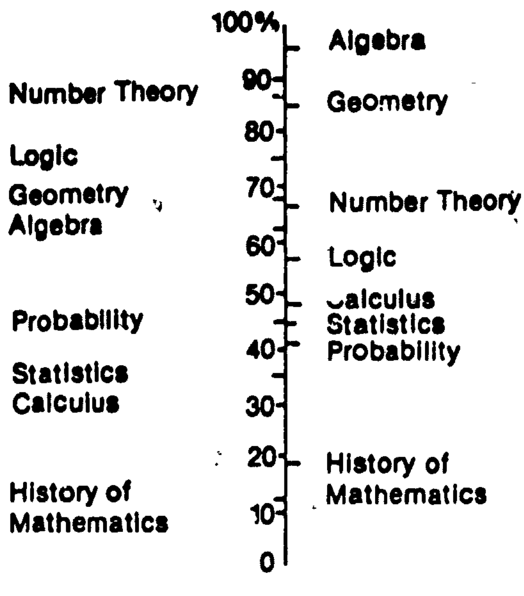

Figure 8-1. Importance of selected areas of mathematics for teacher education.

Four of the eight topics were rated as being Important or Essential to their respective ideal teacher education program by a majority of both groups of teachers; the four were logic, geometry, algebra, and number theory. The four mathematics content areas that were not rated Important or Essential by a majority were probability, statistics, calculus, and, at the bottom of the list, history of mathematics.

Elementary teachers ranked number theory first on their list with 87% of the teachers rating it Important or Essential

compared to 67% of secondary teachers. Secondary mathematics teachers ranked algebra first on their list with 96% of the teachers rating it Important or Essential compared to 62% of the elementary teachers.

Another interesting contrast was the rating of logic. Seventy-five percent of elementary teachers rated logic as Important or Essential, which was 18% greater than the proportion of secondary teachers that rated logic the same way. Elementary teachers' rating of logic was second only to their rating of number theory. It is not known what definition, in specific terms, elementa teachers were using for logic.

The final item in section F asked teachers to rate content courses in disciplines other than mathematics and education. Of eleven disciplines listed, only two were rated as being Important or Essential by a majority of both groups of teachers: English and computer science. Physics was rated Important or Essential by 64% of secondary teachers and 42% of elementary teachers. Astronomy, geology, and engineering were rated Not Important by a greater proportion of elementary teachers than rated them Important or Essential. Astronomy, geology, geography, and psychology were rated Not Important by a greater proportion of secondary teachers than rated them Important or Essential. While it is not surprising that English received the elementary teachers' highest rating, the high rating of computer science is surprising to some extent. This positive response to computer science is, however, consistent with the results for the items in the Calculator and Computer Use section of the questionnaire.

8.6 Part G--Teacher In-service Education

In section G, teachers were asked to rate the degree of help they had received from each of nine groups of persons that offer in-service activities in mathematics. Teachers were then asked to judge the need for workshops in a number of areas. Finally, teachers were asked for their opinion regarding the preferred format for in-service programs.

Groups Offering In-service Activities

The teachers rated each of nine groups that offer in-service activities with respect to the degree of help they had received from each group. A summary of the results is presented in Table 8-4.

Table 8-4
Ratings of Groups Offering In-service Activities

In-service Group	Mean Rating* Elementary	Secondary
Ministry of Education personnel	1.0	1.0
BCTF professional development personnel	1.4	1.3
Local PSA personnel	1.8	1.5
BCAMT workshop speakers	1.5	1.8
University personnel	1,9	1.6
District supervisors, coordinators, or resource teachers	2.1	1.4
Fellow teachers	2.7	2.8
Community resource people	1.6	1.2
Educational consulting firms	1.2	0.9

*Using the following values: Not Helpful At All--0, Somewhat Helpful--1, Moderately Helpful--2, Very Helpful--3, and Extremely Helpful--4.

Only one group offering in-service activities obtained a mean rating greater than 2.5, fellow teachers. Fellow teachers represent the one group that is immediately available, easily accessible, and offers instant feedback to inquiries.

Three of the nine groups were groups from inside the teacher's school district. These three, fellow teachers, district supervisors,coordinators, or resource teachers, and local PSA personnel were three of the four highest rated groups by elementary teachers. The only group from "outside" the district that received a rating in the top four by elementary teachers was university personnel, which was rated third. Secondary teachers, on the other hand, rated both BCAMT workshop speakers and university personnel higher than local PSA personnel or district superisors, coordinators, or resource teachers.

In Figure 8-2, the percent of the teachers, both elementary and secondary, that had had experience with each of the groups offering in-service activities is shown.

There may be two explanations for the strong positive correlation that exists between the proportion of teachers having experience with an in-service group and the rating given the group by teachers. Since all the groups are helpful, the more teachers who had experience with a group, the higher rated the group. More likely, however, is the explanation that the more helpful a group was perceived to be by the teachers,

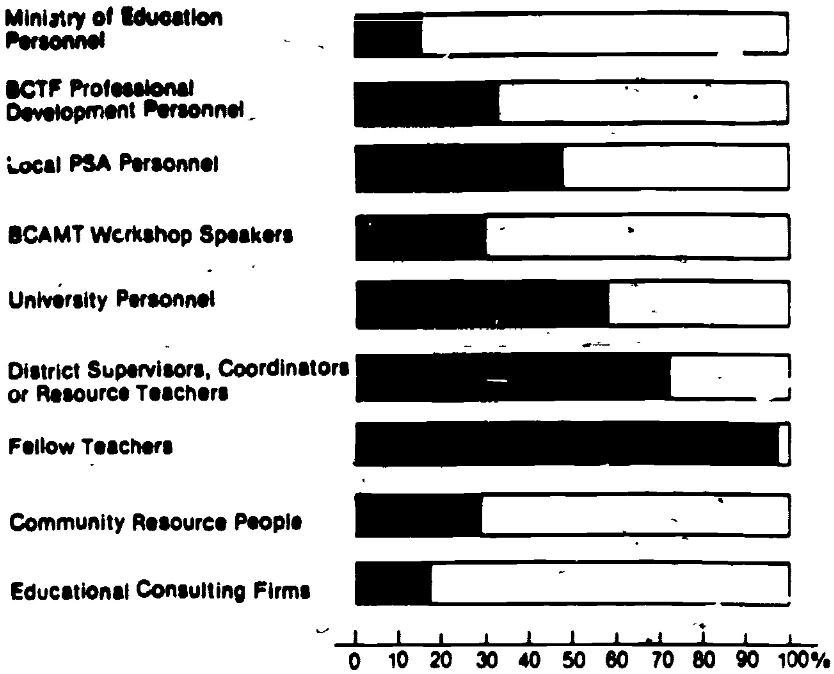

Figure 8-2. Utilization of in-service resources.

the more teachers seek that group's help. A majority of the teachers have had no experience with Ministry of Education personnel, BCTF professional development personnel, local PSA personnel, BCAMT workshop speakers, community resource people, and educational consulting firms.

In-service Format and Topics

Teachers were undecided on the format that in-service workshops should take. Thirty-one percent of elementary teachers felt that a one- to two-hour workshop on one topic was best. However, 29% felt that a series of workshops on one topic was best, and 27% wanted a one-day workshop on one topic. Twelve percent of elementary teachers wanted the workshop to take the form of a degree credit university course and only 1% wanted the format to be a non-credit university course.

Thirty-four percent of the secondary teachers wanted a series of workshops on one topic, while 26% wanted a one-day workshop on one topic. The remaining 40% of secondary teachers were split between the format being a one- to two-hour workshop on one topic (20%) and a university course for degree credit (17%). Very few secondary teachers wanted workshops to take the form of non-credit university courses.

Teachers were presented with a list of topics for in-service workshops and asked to rate the importance of holding workshops on them. The mean rating of each topic is shown in

Table 8-5
Ratings of Suggested In-service Topics

In-service Topic	Mean Rating* Elementary	Secondary
1. Algebraic Topics	**	1.8
2. Applying mathematics to everyday situations	2.0	2.0
3. Calculus	**	0.9
4. Computation with whole numbers	1.9	**
5. Computer literacy	1.5	2.0
6. Consumer mathematics	**	1.8
7. Decimals	1.6	**
8. Diagnosis and remediation	2.4	2.0
9. Enrichment topics	2.3	1.9
10. Fractions	1.5	**
11. Geometry	1.5	1.7
12. Giftedness	1.9	1.7
13. Metric measurement	2.0	1.3
14. Probability and statistics	1.1	1.2
15. Problem solving	2.3	2.1
16. Use of micro-computers	**	2.1
17. Vocational or career mathematics	**	1.8

*Computed using the following values: Not Important--0, Somewhat Important--1, Important--2, and Essential--3.
**This topic appeared only on the other questionnaire.

Table 8-5.

Using the criterion that a mean rating of 1.9 or greater would be considered Important, seven of the 12 topics were rated as Important by elementary teachers. The seven topics were diagnosis and remediation of learning difficulties in mathematics, enrichment topics for elementary school mathematics, problem solving, applying mathematics in everyday situations, metric measurement, giftedness, and computation with whole numbers. Using the same criterion, secondary teachers rated 6 of the 14 topics as Important. The topics were problem solving, use of micro-computers, computer literacy, applying mathematics to everyday situations, diagnosis and remediation, and enrichment topics.

There were several surprises in the results. Both groups of teachers gave probability and statistics mean ratings of 1.2 or less, which is below the Important category. Probability and statistics have been been discussed for inclusion in the elementary mathematics curriculum. The NCTM had an entire strand for probability and statistics at its 1981

Annual Meeting, and the 1981 NCTM Yearbook is Teaching Statistics and Probability. With respect to the importance of offering a workshop in probability and statistics, the topic received the teachers' lowest mean rating.

Secondary teachers gave a mean rating of 1.3 to metric measurement; clearly the two groups of teachers view the importance of metric measurement as an in-service topic differently. The topic has been in the curriculum for almost ten years and literally hundreds of workshops have been presented. A possible explanation is that since parts of the system are still being adopted, elementary teachers felt the need for updating workshops.

Another result which was unexpected, was the mean rating given by elementary teachers to computer literacy, especially in view of their evaluation of its importance elsewhere in the questionnaire. Elementary teachers ranked computer science second of eleven disciplines, other than mathematics and education, in importance in their proposed teacher education program, and 99% of them said that computer literacy should be a topic in the curriculum. The elementary teachers then ranked computer literacy eleventh out of twelve topics in importance with respect to offering an in-service workshop in the topic; however, the mean rating does border on the low side of the Important category. This last result may be largely due to the fact that 88% of the elementary teachers did not have access to computers in their schools.

8.6 Curriculum Models

One of the objectives of the 1981 Assessment was to provide data which would be useful in any future review or revision of the mathematics curriculum in this province. Chapter 2 contains a description of the way in which the field of mathematics affects the contents of school mathematics and the processes for presenting school mathematics. That chapter also contains a description of three models for the mathematics curriculum: the Pure Mathematics model, the Applied Mathematics model, and the Basic Skills model. An attempt was made in the teacher questionnaires to ascertain the curriculum model preferred by the teachers of mathematics.

Definition of Models

Items from the questionnaires whose content was related more or less directly to one of the three models were collected, one collection for each model. The results on the items were then subjected to data analyses, including factor

analysis. Factor analyses were computed in order to determine if the items would cluster in the same sets as those used to define the models.

At the elementary level, the three models had weak to moderate reliability, item correlations that were positive but weak, and items that clustered in only one identifiable model. Since only one factor was identified at the elementary level, no comparisons could be made and further analysis of the data was abandoned.

The results for the elementary teachers are not surprising. In Chapter 2, it is pointed out that first, "There would not appear to be a distinctively Canadian model for the school mathematics curriculum." The models used come from what is in use in the U. S. However, "It is difficult to determine the nature of the curriculum model now prevailing in the United States...there has been a clear move away from much of the New Math content. It is less clear in what direction the curriculum is now heading."

At the secondary level, three factors were identified by the factor analysis. While the three factors were not identical to the three original sets, there were many similarities.

Factor 1 contained nine items: 2 Applied, 1 Basic Skills-Applied, and 6 Basic Skills. The six Basic Skills items dealt with consumer and career mathematics. For example, the teachers who supported this factor felt consumer mathematics should be emphasized in the curriculum, vocational or career mathematics is an important in-service topic, and preparation in teaching consumer, trade, and industrial mathematics is important in a teacher education program. The six Basic Skills items which grouped in the factor analysis form a set called the Real World factor.

Factor 2 contained nine items: 8 Pure Mathematics items and 1 Applied item. The 8 Pure Mathematics items dealt with the traditional topics of school mathematics. For example, teachers who supported this factor felt preparation in teaching algebra and geometry are important in a teacher education program, teaching students to identify geometric figures and solve open sentences are important objectives, and to familiarize students with the major ideas and processes of mathematics was an important overall goal for school mathematics. The 8 Pure Mathematics items which grouped in the factor analysis form a set called the School Mathematics factor.

Factor 3 contained nine items: 5 Pure Mathematics items and 4 Applied items. The nine items tended to deal with applications of mathematics. For example, teachers supporting this factor felt that topics such as using mathematics to predict

and applications to other fields should be emphasized in the curriculum. The nine items form a set called the Applications factor. The final definitions used in the analyses of the curriculum models are presented in Table 8-6.

Table 8-6
Definitions of the Three Factors

Factor	Item Numbers			
Real World (7 items)	12.1	44.2	44.7	48.1
	48.4	48.14	65.5	
School Mathematics (8 items)	12.3	20.2	20.3	20.4
	43.1	44.1	44.3	44.9
Applications (9 items)	48.11	48.12	65.4	65.6
	65.7	65.8	65.10	65.11
	65.12			

Results on Curriculum Model Items

All of the results concerning the three curriculum models concern only secondary mathematics teachers. The responses on each of the items in the three sets defining the curriculum models for all of secondary mathematics teachers were totalled and converted to standardized scores. Each teacher had three scores: the total for the Real World factor, the total for the School Mathematics factor, and the total for the Applications factor. Each teacher was then categorized as supporting one of the factors according to which of his three scores was greatest. There was a relatively even distribution with 36% of secondary mathematics teachers supporting the Real World Factor, 32% supporting the School Mathematics factor, and 31% supporting the Applications factor.

Of the teachers who supported the School Mathematics factor, 55% had taught at least eleven years compared to only 30% of those that supported the Real World factor and 39% of those that supported the Applications factor. Of those who supported the Real World factor, 44% had taught five or fewer years, and 38% of those who supported the Applications factor had taught five or fewer years. Only 24% of secondary teachers who supported the School Mathematics factor had taught five or fewer years. Sixty-three percent of the teachers who supported the School Mathematics factor were those for whom mathematics re-

presented a majority of their teaching load compared to 57% of the teachers who supported the Applications factor and 43% of the teachers who supported the Real World factor. Moreover, of the teachers who supported the Real World factor, 39% were teachers for whom mathematics represented at most only one fourth of their teaching load.

The three groups of teachers were also compared with respect to their post-secondary mathematics courses. The data relating factor preference and post-secondary mathematics experience are presented in Table 8-7.

Table 8-7
Model Preference and Post-Secondary Mathematics Experience
(Percent)

Description	Model Preference		
	Real World	School Mathematics	Applications
Never successfully completed a post-secondary mathematics course	18	3	5
Never successfully completed a mathematics methods course	39	18	24

Of the teachers who supported the Real World factor, 18% had never successfully completed a post-secondary mathematics course and 39% had never successfully completed a mathematics methods course. The proportions compare to the 3% and 18%, respectively, for teachers who supported the School Mathematics factor and 5% and 24%, respectively, for those teachers who supported the Applications factor.

Of those teachers who supported the Real World factor, 46% responded that they would prefer to teach at the junior secondary level. Only 28% of the teachers who supported the School Mathematics factor preferred the junior secondary level while 64% preferred the senior secondary level. The Applications factor, maintaining the middle ground image, had 38% of its teachers select the junior secondary level and 51% select the senior secondary level.

In summary, the Real World factor seems to be preferred by teachers with the least experience, who do not teach mathematics fulltime, and who would prefer to teach at the junior secondary level. In addition, 18% of the teachers who support-

ed the Real World factor had never successfully completed a post-secondary mathematics course, 39% had never successfully completed a course in how to teach mathematics, and barely half had attended a mathematics session at a conference or a workshop or in-service day in mathematics in the past three years.

On the other hand, the School Mathematics factor seems to be preferred by teachers with the most experience, who teach mathematics fulltime, and who would prefer teaching at the senior secondary level. To continue the comparison, only 3% of this group had never successfully completed a post-secondary mathematics course, only 18% had never successfully completed a mathematics methods course, and almost two thirds had attended a mathematics session at a conference and a workshop or in-service day in mathematics in the past three years.

The Applications factor lies between the other two. On eight of the nine background items on which the comparison was made, the results of the teachers supporting the Applications factor were between the results of the teachers preferring one of the other two models.

The remainder of the items used to organize the data on curriculum models dealt with the curriculum, use of computers and computer literacy, activities in the classroom, and the policy for students who do not meet the mathematical requirements for the course.

Teachers were asked to rate the present curriculum with respect to how it meets the needs of their students. Of the teachers supporting the School Mathematics factor, 23% rated the curriculum Very Well compared to only 14% of the teachers supporting the Applications factor and 10% of the teachers supporting the Real World factor.

What should happen to students who do not meet the requirements of the course? There was strong support among all three groups to the effect that the student should repeat the course or take a different course at the same grade level. One other fact of interest, 23% of the teachers preferring the Real World factor felt the best policy was to send such students to a special class within the schoo for remedial work, compared to only 9% of the teachers preferring the School Mathematics factor. The Applications factor was in the middle with 18% of its teachers responding positively to the same policy.

All three groups of teachers felt strongly that computer literacy should be in the curriculum. The Real World factor teachers and the Applications factor teachers preferred that computer literacy be taught as part of several courses, while

the School Mathematics factor teachers were split, 33% to 36%, between that approach and introducing a course in computer literacy.

Regarding the frequency with which the three groups had their students engage in each of eight selected activities, there was a strong positive response from all groups for Individual work, Solving textbook exercises, and Listening to teacher explanation.

The two activities on which there were statistically significant differences were working at activity centres, which was used often by only 2% of the teachers, and drill on arithmetic computation. Of the teachers supporting the Real World factor, 27% responded Frequently or Very Frequently to the activity drill on arithmetic computation compared to 23% of the teachers supporting the Applications factor, but only 12% of the School Mathematics factor teachers responded the same way.

8.8 Summary

The results on the items discussed in this chapter provide a description of an average teacher. A teacher with all the characteristics probably does not exist since the description is a composite.

The average elementary teacher of mathematics has taught five or more years in a self-contained classroom. It is extremely unlikely that this teacher belongs to either the NCTM or the BCAMT. However, it is likely that this teacher has attended a mathematics session at a conference and a workshop or an in-service day in mathematics in the past three years. The average elementary teacher is very positive about teaching at the elementary level and about teaching mathematics.

The average secondary teacher of mathematics has taught five or more years, but not necessarily as a full-time mathematics teacher. It is unlikely that this teacher belongs to either the NCTM or the BCAMT. It is very likely, however, that this teacher has attended a mathematics session at a conference and a workshop or in-service day in mathematics in the past three years. The average teacher is very positive about teaching mathematics and about teaching at the secondary level.

Both elementary and secondary teachers felt the two most important goals for school mathematics are to teach students the mathematical concepts and skills required to function as enlightened consumers in a technological society and to devel-

op in students the ability to think logically. Both groups also felt the least important goal on the list was to develop the idea that mathematics is the science of abstract, deductive structures.

Teacher Education Program

In designing the ideal teacher education program for their respective teaching levels, both groups of teachers felt the most important areas were those that dealt as directly as possible with the teaching experience. This included topics such as methods of teaching mathematics, general teaching skills, and practice teaching. Both groups felt the two least important areas for a teacher education program were content courses in other disciplines and foundation courses in education. It is noteworthy that there was very little support among the secondary teachers for requiring calculus in their ideal teacher education program.

With respect to preparation in specific teaching topics and skills in a teacher education program, both groups gave high ratings to training in teaching problem solving, techniques of classroom management and discipline, techniques of diagnosis and remediation, and teaching applications of mathematics. In addition, the secondary mathematics teachers gave a high rating to teaching metric measurement and teaching the structure of mathematics.

Elementary teachers felt the most important mathematics content area for a teacher education program was number theory; secondary teachers felt algebra was the most important. The only mathematics content area on which the two groups agreed was the history of mathematics: both groups agreed that it was least important. With respect to disciplines other than mathematics and education, the two groups were in agreement that English and computer science were important to a teacher education program. Secondary teachers also felt physics was important to their program.

In-service Education

While fellow teachers was the only group of persons offering in-service assistance that received a high rating from the two groups of teachers surveyed, the teachers were able to agree on several topics for in-service workshops. Both groups rated as important each of the following: diagnosis and remediation of learning difficulties in mathematics, enrichment topics in mathematics, problem solving, applying mathematics to everyday situations, and giftedness. To the list elementary teachers added metric measurement and secondary teachers added

computer literacy.

Sub-populations

Among the teachers who teach mathematics at the secondary school level two sub-groups were identified. The first group, Inadequately Prepared teachers, consisted of teachers who felt their mathematics content courses, mathematics methods courses, and their other education courses had inadequately prepared them to teach mathematics. Compared to the rest of the secondary teachers, fewer Inadequately Prepared teachers had attended mathematics sessions at conferences, fewer had attended mathematics workshops or in-service programs, over 80% of them had not referred to the Guide recently, a majority of them had no experience with seven of the nine groups offering in-service activities.

In preparing an ideal teacher education program for secondary mathematics teachers, 69% of the Inadequately Prepared secondary teachers did not rate courses from the department of mathematics as Essential. A majority of the Inadequately Prepared teachers did not rate preparation in the teaching of algebra as Essential to the preparation of secondary mathematics teachers.

The other sub-group identified was Single Mathematics Class secondary teachers. Almost half the secondary mathematics teachers in B. C. have the majority of their workload in an area other than teaching mathematics. In fact, teachers who teach only one mathematics class (Single Mathematics Class teachers) represent 30% of the teachers of secondary school mathematics.

Twenty-three percent of the Single Mathematics Class teachers had not successfully completed a mathematics content course since graduating from secondary school, 55% had never had a course in how to teach mathematics, 68% had not attended even one mathematics workshop or in-service program in the last three years, 71% had not attended a mathematics session at a conference in the last three years. The proportion of Single Mathematics Class teachers responding that their students engaged in Drill or arithmetic computation Frequently or Very Frequently was over twice as great as the rest of the secondary teachers. About half of the Single Mathematics Class teachers did not use calculators with their mathematics class and would not allow their students to use them either.

Curriculum Models

Since only one model was identified for elementary teachers, all the comparisons of model preference were at the secondary level. Three models were identified at the secondary level. A set of items from the questionnaire was used to define each model--Real World factor, School Mathematics factor, and Applications factor. Each teacher was given a composite score for each model and categorized as supporting the model for which the score was the greatest.

The Real World factor teachers were teachers with the fewest years of teaching experience, did not teach mathematics fulltime, and preferred to teach at the junior secondary level. Of the three groups of teachers, Real World factor teachers had the highest proportion who had not completed a post-secondary mathematics content course, had not completed a course in how to teach mathematics, and had not attended a conference session, workshop or in-service program in mathematics in the past three years. Of the three groups, Real World factor teachers had the lowest proportion respond that the present curriculum was doing very well at meeting the needs of their students.

The School Mathematics factor teachers were teachers with the most teaching experience, taught mathematics fulltime, and preferred teaching at the senior secondary level. Of the three groups of teachers, School Mathematics factor teachers had the lowest proportion who had not completed a post-secondary mathematics content course, had not completed a course in how to teach mathematics, and had not attended a conference session in mathematics in the last three years. Of the three groups of teachers, School Mathematics factor teachers had the highest proportion respond that the present curriculum was doing very well at meeting the needs of their students.

The Applications factor teachers' results were between the other two groups on eight of the nine background items. In terms of preparation, they were like the School Mathematics factor teachers; in terms of teaching experience, they were more like the Real World factor teachers. On the other comparisons, their results were equally different from both of the other two groups.

The three groups had the same preference of what to do with students who do not meet the mathematical requirements of their course: have such students repeat the course or another course at the same level. All three groups gave strong support to having computer literacy as part of the curriculum (though not necessarily the mathematics curriculum).

All three groups had their students engaged in the same three of the eight activities listed. The groups differed on the frequency of drill on arithmetic computation. About one

fourth of the Real World and Application factor teachers had their students engaged in the activity often compared to 12% of the School Mathematics factor teachers.

The results do support the discussion in Chapter 2 that different curriculum models do exist among teachers. Also, the models are related to certain factors in teachers' backgrounds and how they approach teaching mathematics.

8.9 References

Robitaille, D. F. and Sherrill, J. M.. British Columbia Mathematics Assessment, 1977: Instructional Practices. Victoria, B. C.: Ministry of Education.

CHAPTEP 9

INSTRUCTIONAL PRACTICES

James M. Sherrill and David F. Robitaille

One of the most important parts of the process of teaching mathematics is what actually transpires in the classrooms where mathematics is being taught. As part of the teacher questionnaires, data were sought concerning the instructional practices used in the teaching of mathematics. The results of the analysis of those data are the focus of the discussion presented in this chapter.

9.1 Part C--Program Implementation

The main topics of this section of the questionnaires were the use of the curriculum guides, textbooks, and metric materials in the implementation of the mathematics program. In the discussion that follows, the term "Guide" refers to the Mathematics Curriculum Guide Years One to Twelve issued by the B. C. Ministry of Education in 1978. It is the Guide that sets out the mathematics curriculum that teachers are expected to teach.

Guide

Over 80% of the teachers indicated that they had referred to the Guide in the last year. In rating the comparative influence of textbooks, the local curriculum, and the Guide on their selection of content for the teaching of mathematics, the teachers felt the Guide was the most important, with two thirds of the teachers rating it as either Important or Essential.

One result related years of teaching experience and the relative importance the teachers give textbooks and the local curriculum when selecting course content. The more teaching experience a teacher has the less likely it is that the teacher will consider the textbook Essential when selecting mathematics course content. Thirty-five percent of elementary teachers with one to two years of experience rated textbooks as Essential while only 18% of the elementary teachers with eleven to fifteen years of experience did so. Also of interest is the finding that senior secondary ~~teachers~~ rated the text-

book as Important or Essential more often than junior secondary teachers.

The teachers were asked to read each of ten statements concerning the Guide, and curriculum guides in general, and to indicate how strongly they agreed or disagreed with each statement. The results are presented in Table 9-1.

Table 9-1
Opinions About Curriculum Guides
(Percent)

Statement	Negative Response* E**	Negative Response* S	Positive Response E	Positive Response S
1. No curriculum guide is needed	91	90	5	6
2. The format of the current Curriculum Guide is adequate as it is	29	32	51	45
3. The format of the current Curriculum Guide needs to be revised	31	28	38	41
4. Topics in a curriculum guide should be listed separately for each grade	10	11	83	74
5. A curriculum guide should contain a suggested teaching order for topics for a grade	18	20	76	70
6. A curriculum guide should include recommendations for appropriate methods and materials	12	14	80	74
7. Time allocations should be suggested for each topic in a curriculum guide	31	15	60	76
8. Minimal objectives for each grade should be specified in a curriculum guide	8	4	88	91
9. For each grade, a single textbook should be adopted as the basic textbook in mathematics	58	50	34	39
10. Any future curriculum guide should be supplemented with one or more resource books	4	3	82	83

*Negative Response is Disagree or Strongly Disagree and Positive Response is Agree or Strongly Agree
**E--Elementary teachers, S--Secondary teachers

There was strong support for the idea of having a curriculum guide, with 90% of the teachers giving a negative response to the statement "No curriculum guide is needed." The

teachers gave a strong positive response that a guide should be supplemented with one or more resource books (82%), should specify the minimal objectives for each grade (90%), should list the topics to be taught separately for each grade (79%), should include recommendations for appropriate methods and materials (77%), and should suggest a teaching order for topics for a grade (73%). While the response was positive toward the suggestion that a curriculum guide should contain time allocations for each topic, 16% more of secondary teachers than elementary teachers agreed. There was only moderate support for continuing to adopt more than one basic mathematics textbook for a given grade or course.

Though teachers had rather strong opinions about what a curriculum guide should do, there was only slight support for revising the format of the current Guide. This result may be an example of one of the factors discussed in the introduction to Chapter 8. All four suggestions for what a curriculum guide should do, that the Guide does not do, received positive response ranging from 67% to 82% in favor; however, the teachers were split over whether the Guide should be revised.

Looking at the data on what a curriculum guide should do when the replies are grouped by years of teaching experience yielded some persistent findings. Less experienced elementary teachers (1 - 2 years) gave a more positive response than the rest of the elementary teachers that a guide should include the teaching order and time allocations for topics and recommendations for methods and materials. The same finding was true for secondary teachers with respect to the guide including recommended methods and materials. Another finding concerning years of teaching experience was that a higher proportion of more experienced secondary teachers (six or more years) responded that the Guide should be revised.

In the Guide are listed five major cognitive goals for the mathematics curriculum. Teachers were asked to rate these according to how important they considered those goals to be, using the descriptors Not Important(0), Somewhat Important(1), Important(2), and Essential(3). The mean ratings of the two teacher groups are presented in Table 9-2.

The results show that, of the major cognitive goals listed in the Guide, two were considered especially important by teachers. Over half of them said that it is essential that the mathematics program enable students to identify and use the basic properties and operations of the real number system. Almost half said that it is essential that the mathematics program enable students to apply knowledge of mathematics to familiar physical or environmental situations in order to construct a descriptive mathematical model of the situation or to solve a problem arising from the situation. All five major

Table 9-2
Ratings of Cognitive Goals

The mathematics program will enable the student:	Mean Rating* Elementary	Secondary
1. To identify and use the basic properties and operations of the real number system	2.7	2.5
2. To identify common geometric figures and demonstrate a knowledge of their basic properties	1.7	2.0
3. To transform given numerical and algebraic expressions into equivalent expressions	1.7	2.0
4. To solve open sentences of various types and degrees of complexity	2.0	2.1
5. To apply knowledge of mathematics to familiar physical or environmental situations in order to construct a descriptive mathematical model of the situation or to solve a problem arising from the situation	2.4	2.3

*The mean rating was computed using the following values: Not Important--0, Somewhat Important--1, Important--2, and Essential--3.

cognitive goals were rated Important or Essential by over 60% of the teachers. In addition, over 96% felt that the list of major cognitive goals coincided Quite Well or Very Well with their views of what the major cognitive goals of the mathematics curriculum should be.

Textbooks

Over 70% of the Grade 1 to 6 teachers indicated that they use Investigating School Mathematics(ISM) as their basic textbook with an additional 24% using the book as a supplementary textbook. Only 5% of the Grade 1 to 6 teachers were not using ISM. The second most commonly used basic text at the elementary level was Heath Elementary Mathematics, but only 18% of the Grade 1-6 teachers used it as a basic text Over 60% of the Grade 1 to 6 classes were not using Project Mathematics at all.

At the Grade 7 level, 74% of the teachers indicated that they use School Mathematics I (SMI) as their basic textbook. This is 2.5 times more teachers than were using any other textbook as their basic text. An additional 16% of the Grade 7 teachers were also using SMI as a supplementary textbook. Only 10% of the Grade 7 classes were not using SMI. Mathematics I was used as a basic textbook by 30% of the Grade 7 teachers.[1]

There are three prescribed textbooks for the Mathematics 8 course. Forty percent of the Grade 8 mathematics teachers indicated that they use Mathematics II as their basic textbook, with an additional 27% of the teachers using it as a supplementary or resource textbook. Thirty-five percent indicated that School Mathematics II was their basic textbook. and another 33% of the teachers list it as a supplementary or resource textbook. The other currently adopted Mathematics 8 textbook, Essentials of Mathematics 2, was listed as a basic textbook by only 7% of the teachers. Another 30% used it as a supplementary or resource textbook.

For Mathematics 9, Mathematics for a Modern World, Book 1 was predominant, having been listed as the basic text by 60% of the teachers. Modern Algebra, Book 1, Modules 1, 2, 3, was listed as a basic text by 29% of the teachers. The other three currently adopted Mathematics 9 textbooks were listed as a basic text by less than 10% of the teachers.

In Mathematics 10 three books were used as basic texts by more than 20% of the teachers. Leading the list was Mathematics for a Modern World, Book 2 (56%), followed by Modern Algebra, Book 1, Modules 4, 5, 6 (29%) and Business and Consumer Mathematics (22%). Mathematical Pursuits, Two was listed as a basic text by only 0.2% of the teachers.

In Grade 11 there are three courses: Algebra 11, Consumer Mathematics 11, and Trades Mathematics 11, but the last two have relatively small enrollments. For Algebra 11 Using Advanced Algebra was listed as the basic text by 76% of the teachers, and only 8% of the teachers indicated that they did not use this text at all. Twenty-three percent of the teachers listed Modern Algebra and Trigonometry, Book 2 as their basic text with another 50% of the teachers listing it as a supplementary rescurce text for their Algebra 11 courses.

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[1]The total percentage exceeds 100% because schools are encouraged to adopt more than one of the prescribed texts for each grade.

The Consumer Mathematics 11 market was split between Business and Consumer Mathematics, with 38% listing it as a basic text and 24% using it as a supplementary text, and Contemporary Business Mathematics, with 35% listing it as a basic text and 22% using it as a supplementary text.

Basic Mathematics Simplified was listed as a basic text by 52% of the Trades Mathematics 11 teachers compared to 16% listing Practical Problems in Mathematics Series.

In Grade 12 there are also three basic courses: Algebra 12, Geometry 12, and Probability and Statistics 12. There are five textbooks on the Algebra 12 list, but only two were in widespread use. Using Advanced Algebra was listed as a basic text by 60% of the teachers, with an additional 20% of the teachers using it as a supplementary text. Modern Algebra and Trigonometry , Book 2 was listed as a basic text by 44% of the teachers, but another 36% listed it as a supplementary book. Pre-calculus Mathematics was the third most commonly listed basic text with only 13% of the teachers saying that they use it as the basic text.

Only one text is prescribed for Geometry 12, and only one for Probability and Statistics 12. Twenty-four percent of the Geometry 12 teachers said they used Geometry (B.C. Metric Edition) as the basic text for the course, and only 19% of the Probability and Statistics 12 teachers said they used Probability and Statistics as the basic text for that course. About 56% of the teachers in each course said they did not use the prescribed text at all.

Metric Reference Material

Teachers were asked which of the Ministry-provided metric reference materials they had used, how they had used the materials, and how often. Three out of every eight elementary teachers and three out of every five secondary teachers had used none of the seven metric reference materials listed on the questionnaire. About one third of the elementary teachers had used Introduction to the Metric System or A Pocket Guide To Metrics. About one fourth of the teachers had used Practical Activities for Introducing the Metric System in the Elementary Grades or A Metric Familiarization Workshop. The most commonly used item on the list for the secondary teachers, A Pocket Guide to Metrics, was listed as having been used by only 23% of the teachers. These results may be due to the availability of other metric reference material, to the fact that mathematics textbooks are metric, or to a belief by teachers that students' prior training in the metric system makes using the metric reference materials unnecessary.

Required Courses and Specialists

The final two items in the Program Implementation section concerned the highest grade in which all students should be required to take mathematics, and the levels at which mathematics should be taught by a specialist. Fewer than 3% of the teachers felt that the last year of required mathematics should be any one of Grades 1 to 9.

Teachers' opinions differed as to whether Grade 10, 11, or 12 should be the highest grade mathematics is required as is shown in Table 9-3.

Table 9-3
Highest Grade For Required Mathematics
(Percent)

Grade	Teaching Level		
	Elementary	Junior Secondary	Senior Secondary
10	18	26	30
11	13	36	48
12	62	32	18

Sixty-two percent of elementary teachers felt mathematics should be required every year, Grades 1 to 12. Two thirds of the teachers agreed that whether Grade 11 or 12 is the last year, mathematics should be required of all students beyond the current Grade 10 level. Interestingly, the proportion of junior secondary teachers who listed Grade 12 as the highest year was almost double the proportion of senior secondary teachers who did so.

There was strong support among teachers for requiring that secondary school mathematics be taught by a specialist. On the other hand, teachers still feel that primary level mathematics should be taught by generalists. Only 16% of the elementary teachers and 26% of the secondary teachers felt primary level mathematics should be taught by specialists. Support was stronger, 32% of the elementary teachers and a majority (52%) of the secondary teachers for having intermediate level mathematics taught by specialists.

There was one item in the Program Implementation section that appeared only on the secondary teachers form of the questionnaire. That item concerned three ways of organizing the

secondary program in mathematics. Teachers were asked to respond by marking which organization they felt was most appropriate for the junior secondary program and then for the senior secondary program. The teachers responded that for both the junior and senior secondary program, the organization they preferred was the one that allowed different programs, with classes grouped by ability. Such an organization was preferred by 58% of the teachers for the junior secondary program and by 86% for the senior secondary program. Given such a strong preference at the senior secondary level, it is not surprising that the other two organizational patterns received little support, less than 9% in fact. For the junior secondary level, on the other hand, 29% of teachers preferred an organization which required all students to follow the same basic course but still used ability grouping for classes.

9.2 Part D--Calculators and Computers

Section D, Calculator and Computer Use, dealt mainly with availability and use of calculators and computers. There were items which dealt with the levels at which students should be allowed to use calculators and be introduced to computers, how computers are used in schools and how computer literacy should be handled in the B. C. curriculum. The last subsection in Part D of the questionnaire contained items on the micro-computer specifically. The micro-computer items dealt with teacher access to micro-computers and organization of micro-computer workshops.

Calculators

Over 90% of the teachers felt that students should be permitted to use calculators in mathematics classes at some level. The support for allowing students to use calculators was strongest for the senior secondary mathematics classes, over 80%, and a majority of the teachers supported student use of calculators in junior secondary mathematics classes. Over one third of the elementary teachers felt that students should be allowed to use calculators in Grades 4 to 7, but there was very little support among secondary teachers for permitting students in Grades 4 to 7 to use calculators. There was very little support among teachers for students using calculators in Grades 1 to 3 mathematics classes.

Computers in the Classroom

Not surprisingly, a much higher proportion of secondary teachers than elementary teachers indicated that a computer was available in their schools for instructional purposes, 61% to 12%. Of the 12% of elementary teachers, three fifths indi-

cated that the computer was used in some mathematics classes. About one half said that the computer was used in some class other than mathematics or computer science, and 45% of them said that the computer was used by a computer club or other extra-curricular groups. Of the 61% of the secondary teachers who had a computer available to them, 68% said that it was used in a computer science course; 64% said that it was used in some mathematics classes; 62% said that it was used by a computer club or other extra-curricular group; 43% responded that it was used in some classes other than mathematics or computer science. The uses the two teacher groups make of the computer in their mathematics classrooms are quite different as is shown in Table 9-4.

Table 9-4
Uses of Computers
(Percent)

Uses	Elementary	Secondary
Computer is used as a teaching tool to demonstrate concepts	30	45
Students use the computer for drill and practice	83	30
Students learn computer programming	33	68
Students use the computer to solve problems that are a normal part of the mathematics course	27	37
Students use the computer to solve enrichment problems that are an optional part of the mathematics course	43	33

Only 24% of elementary teachers that had computers available made use of computers in their classrooms. By far the most common (83%) use made of computers by elementary teachers was for drill and practice, Forty-three percent of the elementary teachers who used computers in their mathematics classes did so for enrichment purposes.

It should be noted that the elementary teachers who used the computer in their mathematics classes represented less than 3% of elementary teachers responding to the questionnaire. However, it should also be noted that almost 70% of the elementary teachers responding to the questionnaire felt that students should be introduced to computers by Grade 7. This result combined with the result that 99% of elementary

PAGES 249-250 MISSING FROM DOCUMENT PRIOR TO ITS BEING SHIPPED TO EDRS FOR FILMING.

Table 9-6
Instructional Uses of Computers in Secondary School
(Percent)

The computer is used	1977	1981
by extra-curricular groups	34	62
in some mathematics classes	69	64
in a computer science course	62	68
in other classes	34	43

9.3 Part E--Assessment and Testing

Part E of the questionnaire consisted of items concerning the impact of the 1977 B. C. Mathematics Assessment and the use of achievement tests published by the Ministry of Education and standardized tests in mathematics. The secondary questionnaire also contained an item concerning placement tests in mathematics.

Assessment Reports

As is shown in Table 9-7, a higher proportion of secondary teachers than elementary teachers had read one or more of the reports of the 1977 Assessment. This comparison should

Table 9-7
Percent of Teachers Who Have Read A 1977 Assessment Report

Publication(s)	Elementary Teachers	Secondary Teachers
District Interpretation Report	19	31
Summary Report	20	34
Test Report	22	33
Instructional Practices Report	5	15
None of the above	66	53

come as no surprise. Mathematics is the secondary teachers' major professional interest. The elementary teachers, on the other hand, are generalists with interests in several school subjects and mathematics represents less than one fourth of the workload for over 80% of them. However, over one third of the elementary teachers and almost half of the secondary teachers had read at least one of the reports. It is somewhat

disappointing that only 10% of the teachers had read the report that dealt specifically with the way in which mathematics is taught.

Teachers were asked to rate the degree of impact the results and recommendations of the 1977 Assessment had. One of the direct results of not having read any of the reports is one does not know what impact, if any, the Assessment has had. Over the eight suggested areas, the percent of teachers responding "I don't know" ranged from 40% to 50% for secondary teachers and 46% to 54% for elementary teachers.

For five of the eight areas more teachers felt the 1977 Assessment had had impact than felt that it had had no impact. The five were the areas dealing with curriculum emphasis, supplementary materials, remedial services, evaluation and instructional practices. Whether these results reflect the true state of affairs or whether the areas on which the B. C. Mathematics Assessment has had impact have not been communicated to the teachers is unknown.

Almost 40% of the teachers felt that the results and recommendations of the 1977 Assessment had had some impact on their own teaching. Since about 40% of the teachers had read one of the 1977 Assessment reports, it is diffi lt to interpret this finding. It may be that almost every teacher who had read one of the reports felt the results and recommendation had had impact on their teaching.

Use of Tests

Teachers were asked if they had used two types of tests; standardized tests and the curriculum-based achievement tests produced by the Ministry of Education. The curriculum-based achievement tests (Mathematics Achievement Tests) were produced in a Ministry-sponsored project, the Mathematics Achievement Test Project.

The Mathematics Achievement Tests were produced to try to meet a need among mathematics teachers for tests that were based on the B. C. curriculum. Mathematics Achievement Tests were created for three levels (3/4, 7/8, 10/11). At any one level, 3/4 for example, the tests were designed for achievement evaluation at the Grade 3 level and diagnostic purposes at the Grade 4 level.

Since the tests were designed for use only at specified grade levels, the data were analyzed to determine what percentage of the Grade 7 and 8 teachers, for example, used the Grade 7/8 applications test. The data in Table 9-8 are based on the number of Grade 3 and 4 teachers for the three Grade 3/4 tests; Grade 7 and 8 teachers for the five Grade 7/8

tests; Mathematics 10 and Algebra 11 teachers for the Grade 10/11 Algebra test; Mathematics 10, Algebra 11, and Geometry 12 teachers for the Grade 10/11 Geometry and Measurement test; Mathematics 10, Algebra 11, and Consumer Mathematics 11 teachers for the Grade 10/11 Consumer Mathematics test; Algebra 11 and Algebra 12 teachers for the Algebra 11 test; Algebra 12 teachers for both the Algebra 12 (BCAMT Version) test and the Algebra 12 (Revised) test. The difficulty in this approach at the elementary school level is split classes. A teacher might have a split Grades 2 and 3 class, be listed as a Grade 2 teacher, have used the tests, but would not be counted. At the secondary school level the difficulty is the teacher that teaches several different mathematics courses. A person who teaches both Grade 8 and Grade 12 may have identified himself as a Grade 8 teacher, but marked that he had used the Algebra 12 (BCAMT Version), such a teacher could not be counted in the rate of use for the test. For that reason, the data in Table 9-8 should be considered as corservative estimates of the actual usage of the tests.

Table 9-8
Use of Mathematics Achievement Tests

Tests		Percent
Grade 3/4	Sets and Numbers	32
Grade 3/4	Operations with Whole Numbers	37
Grade 3/4	Geometry and Measurement	27
Grade 7/8	Sets and Numbers	26
Grade 7/8	Operations with Whole Numbers	33
Grade 7/8	Operations with Rational Numbers	30
Grade 7/8	Geometry and Measurement	25
Grade 7/8	Applications	23
Grade 10/11	Algebra	38
Grade 10/11	Geometry and Measurement	27
Grade 10/11	Consumer Mathematics	27
Algebra 11		52
Algebra 12	(BCAMT Version)	54
Algebra 12	(Revised)	55

Since the Ministry originated the project that produced the tests because of requests from teachers for valid and reliable tests linked to the B. C. curriculum, it is not surprising that such a large segment of the teachers is using them. The rate of usage for each Grade 3/4 and Grade 7/8 test

listed in Table 9-8 makes them second only to the Canadian Test of Basic Skills in use in the Grade 3, Grade 4, Grade 7, or Grade 8 classrooms in B C. The rate of usage for the Grade 10/11 tests, Algebra 11 test, and the two Algebra 12 tests make them the most commonly used tests in the Grades 10-12 mathematics classrooms.

While the Mathematics Achievement Tests were designed to be used by specific groups of teachers, there are standardized tests available that have test forms for each of the grade levels. Teachers were asked which standardized tests, from a list of eleven, they used in their classes. The results are presented in Table 9-9.

Table 9-9
Percentage of Teachers Using Standardized Tests

Tests	Elementary	Secondary
1. California Achievement Test	2	1
2. Canadian Test of Basic Skills	58	13
3. Comprehensive Test of Basic Skills	4	2
4. Iowa Tests of Educational Development	1	1
5. Key Math	4	2
6. Metropolitan Achievement Tests	11	2
7. Sequential Tests of Educational Progress (STEP)	0	1
8. Stanford Achievement Tests	17	6
9. Stanford Diagnostic Mathematics Tests	7	8
10. Tests of Academic Progress (TAP)	0	1
11. Test accompanying the textbooks	42	25
12. None	21	56

The only test in common use in the elementary classrooms was the Canadian Test of Basic Skills which had been used by 58% of elementary teachers. Forty-two percent of teachers used the tests that accompany the various mathematics textbooks used in Grades 1 to 7. Twenty-one percent of teachers had not used any of the standardized tests that were listed.

Over half of secondary teachers had not used any of the standardized tests on the list. About one fourth of secondary teachers used the tests which accompany the various mathematics textbooks used in Grades 8 to 12. Of the standardized tests listed by name, the Canadian Test of Basic Skills was used most often, but by only 13% of secondary teachers.

Secondary teachers were also asked whether or not a test, analogous to the English Placement Test, should be used for mathematics to determine university placement. A majority (53%) of the secondary teachers were in favor of such a test.

9.4 Part H--Class-Specific Information

The final part of the questionnaires contained items concerning a specific mathematics class. Teachers identified one specific mathematics class and responded to the items in Part H with that class in mind.

After the class was identified, several items were used to describe the ability level of the class, the class size, the frequency of certain types of instructional activities, activities used in the last meeting of the class, the use of textbooks, and the use of calculators. Also included were items that dealt with time to prepare the lesson for the previous meeting of the class, time to grade the last homework assignment, and an estimate of how long students needed to complete the last homework assignment. Teachers rated the importance of different evaluation techniques and what should happen if students are not successful in fulfilling the mathematics requirements for the class. Other items dealt with the effectiveness of the prescribed curriculum, which topics in the curriculum are being emphasized in the class, and to what degree each of the same topics should be emphasized.

Elementary teachers were also asked, in Part H, to respond to items concerning the amount of mathematics instruction the class receives and whether the time allowed for mathematics instruction is sufficient.

Class Description

Elementary teachers tended to judge their class' mathematical ability to be "about the same" as other classes at the same grade level more often than secondary mathematics teachers (64% to 51%). Both groups of teachers felt the range of mathematical ability in their specified class was either Fairly Wide or Very Wide with more than 80% of the teachers responding in one of those categories. The average class size ranged from twenty-one to twenty-six. The average primary class was 21 students, the average intermediate class was 25 students, the average junior secondary class was 26 students, and the average senior secondary class was 25 students. The average class size for the elementary grades was 23.1, down from 25.0 in 1977. The average class size at the secondary level was 25.6, down from 29.3 in 1977.

One should keep in mind when comparing the 1981 and 1977 results in this section that 1981 teachers were responding with <u>one particular class</u> in mind. For elementary teachers this restriction has no effect, but for a secondary mathematics teacher the specified class may, in some ways, be very different from the rest of the teacher's classes.

On the average, an elementary class has mathematics for five periods in each five-day week, and each period is about 40 minutes long. Some elementary teachers felt they needed more time to teach the mathematics to their classes. The proportion of teachers that felt they needed more time was much greater than the proportion who felt they had more than enough time.

Classroom Activities

Both groups of teachers rated each of eight activities with respect to how frequently each activity was used in their mathematics class. The results are shown in Table 9-10.

Table 9-10
Use of Instructional Time
(Percent)

Activities	Elementary		Secondary	
	Not Used*	Used**	Not Used	Used
1. Oral work	1	82	8	56
2. Individual work	2	86	3	91
3. Small group work	18	39	45	20
4. Solving textbook exercises	7	77	3	88
5. Working on creative mathematics projects	40	12	68	4
6. Listening to teacher explanation (demonstration)	1	77	1	82
7. Working at activity centres	49	17	93	1
8. Drill on arithmetic computation	5	77	46	21

*Percent of teachers responding Never or Rarely.
**Percent of teachers responding Frequently or Very Frequently.

Individual work, oral work, solving textbook exercises, and listening to teacher explanation (demonstration) were used often by a majority of teachers. In addition, over three fourths of elementary teachers had their students engaged in

drill on arithmetic computation quite often. Forty-six percent of secondary mathematics teachers responded that their students Rarely or Never engaged in drill on arithmetic computation (this percentage is 70% for senior secondary mathematics teachers).

One surprising result was that neither group made frequent use of Small group work or Working at activity centres. It appears that the students sitting at their desks, listening to the teacher, then solving textbook exercises is not an unrealistic description of mathematics classrooms at both the elementary and secondary levels.

In 1977 teachers were asked to rate the same eight activities with respect to how frequently their students engaged in each. The results for both years for both groups of teachers are presented in Table 9-11.

Table 9-11
Frequency of Use of Selected Activities
(Percent)

Activity	Elementary		Secondary	
	1977	1981	1977	1981
Oral work	81*	82	56	56
Individual work	81	86	82	91
Small group work	45	39	19	20
Solving textbook exercises	75	77	87	88
Working on creative mathematics projects	13	12	4	4
Listening to teacher explanation (demonstration)	83	77	87	82
Working at activity centres	18	17	0	1
Drill on arithmetic computation**	78	77	39	21

*Percent of teachers marking Frequently or Very Frequently.
**On the 1977 elementary form the activity was "Drill on basic number facts".

The interesting finding that exists in the data for both groups is how little change there has been. This is particularly true of the data for the elementary teachers. The most extreme changes in the data for the elementary teachers occurred for listening to teacher explanation (demonstration) and small group work, both of which had 6% fewer teachers respond Frequently or Very Frequently than in 1977. While a 6% shift may be statistically significant, it is not educationally significant. The significance of the data for the

elementary teachers is that little or no change has occurred since 1977.

For secondary mathematics teachers there was a 9% increase from 1977 to 1981 in the level of support for individual work. The largest shift in all the data, however, reflects how unimportant or inappropriate the secondary mathematics teachers consider drill on arithmetic computation to be for secondary mathematics students. In 1977 drill on arithmetic computation received weak support, with only 39% of the sample marking Frequently or Very Frequently; in 1981 the level of support was at barely half that level with only 21% of the sample responding the same way.

For some items in Part H use was made of the concept of responding to an item with respect to only the last meeting of a class. The following statement appeared before those items:

> Several of the following questions ask for information about the last period you had with this class. While your response for this last period may not be typical of what you usually do, the sum of responses from all teachers will provide a representative picture for the entire province.

If only one teacher were responding to each question, one could get an atypical response. For example, in responding to the item concerning lesson preparation time, the last lesson might have been a chapter review and only took five minutes to prepare. One can see how a person could think that the results might show that teachers take only five minutes to prepare for their mathematics classes when normally that very teacher might take 3-4 times as long to prepare a lesson. In the actual data, it turns out that 59 elementary teachers responded with five minutes, but 850 elementary teachers responded to the item, not just one. Given that a large number of teachers are responding, each to their last period with their specific class, the result is a representative picture for the entire province.

It took the secondary mathematics teachers longer than the elementary teachers to prepare the lesson for their last period with the specified class (24 minutes to 18 minutes). Not surprisingly, the last homework assignment made in the

specified class took the average elementary student less time to work (19 minutes compared to 30 minutes) and the elementary teacher less time to grade (29 minutes compared to 43 minutes). It is also worth noting that 30% of the elementary teachers responded in a way that is interpreted to mean that they had not given any homework assignment in the specified class.

Both groups of teachers were presented with a list of eight activities that are used in mathematics classes. The teachers were asked to respond with the percent of their last period with the specified class that was spent in each activity. The most common response for each activity is presented in Table 9-12.

Table 9-12
Percent of Time Spent on Activities
(Mode)

Activity	Elementary	Secondary
1. Large group instruction on a new topic	20*	20
2. Small group instruction on a new topic	10	10
3. Individual instruction on a new topic	10	10
4. Supervising seatwork on a new assignment	20	20
5. Correcting previous assignments	10	10
6. Giving tests or quizzes	10	10
7. Reviewing previously taught material	10	10
8. Other	10	10
TOTAL	100	100

*In describing each activity for one class, the mode was zero in 7 of the 8 instances. The mode reported in the table is the mode excluding all teachers who did not use the activity in the last class.

The mode for elementary teachers is exactly the same as the mode for secondary mathematics teachers for each of the eight activities. Elementary classes in mathematics and secondary mathematics classes appeared to be very similar with respect to the percent of time spent on each of the eight activities listed. The most common activities were large group instruction on a new topic and supervising seatwork on a new assignment.

There can be little doubt as to the major use teachers made of textbooks. Both the elementary and secondary teachers

responded overwhelmingly that the major use they made of the textbooks was for exercises. If, as it appears, the overwhelming majority of teachers use the textbook only as a source of exercises, then the current textbook type should be changed. It appears as if the student is not expected to read his textbook (which was a finding in the 1977 Assessment), but only solve the exercises.

Evaluation

Teacher responses gave clear results with respect to which evaluation techniques the teachers consider important. The results from the two groups are presented in Table 9-13.

Table 9-13
Evaluation Techniques Used in Class
(Percent)

Evaluation Technique	Percent of Teachers Responding Important or Essential	
	Elementary	Secondary
1. Teacher observations of students' performance	96	64
2. Teacher-prepared tests	89	98
3. Tests prepared by school personnel	19	33
4. Tests prepared by district office personnel	19	9
5. Ministry-supplied classroom achievement tests	19	14
6. Tests accompanying mathematics series	46	19
7. Commercially-produced standardized tests	16	5

Teachers considered teacher-prepared tests and teacher observation of students' performance to be the two most important evaluation techniques. These two techniques were the only two given a high rating by a majority of teachers. Almost 90% of elementary teachers rated both teacher observation of students' performance and teacher-prepared tests as Important or Essential. Secondary teachers rated teacher observation of students' performance second but almost one third fewer secondary teachers rated it Important or Essential compared to teacher-prepared tests, which is clearly their first choice.

Given that 93% of the teachers rated teacher-prepared tests as Important or Essential and 81% rated teacher observations similarly, efforts must be made that teachers receive training in test construction and observation techniques.

What to do with students who are evaluated as being unsuccessful in fulfilling the mathematics requirements for the specified course was addressed by both groups of teachers, but with different items. There are more choices as to what one can do with such students at the secondary level. The results on both items are presented in Table 9-14. The last three suggested policies listed in Table 9-14 appeared on the secondary form only.

Table 9-14
Recommended Policy for Students Who Fail Requirements
(Percent)

Policy	Level of Support	
The Student should...	Elementary	Secondary
...go to a special class within the school for remedial work	75	17
...go to a special school for remedial work	0	1
...proceed to the next higher grade level with their classmates	16	3
...repeat the course	9	49
...repeat the entire grade	0	0
...not be permitted to take any more mathematics courses	*	1
...take a different mathematics course at the same grade level	*	28
...proceed to the next higher mathematics course with their classmates	*	1

*Appeared on the secondary questionnaire only.

Three-fourths of elementary teachers were in favor of keeping the students in the same school, but sending them to a special class for remedial work. Since the secondary teachers have more options open to them, it is not surprising that no single suggested policy received support from a majority of teachers Having students repeat the course, however, won support from 49% of secondary mathematics teachers. Combining the responses to two policies indicate that 77% of secondary mathematics teachers support having the students take the same

course over or another course at the same grade level; both of these options are available while keeping the students in the same grade with their classmates; such options are not easily achieved at the elementary level.

Curriculum

Both groups of teachers felt the present B. C. mathematics curriculum is doing an adequate or better than adequate job of meeting the needs of their students in the specified class. Teachers were asked to indicate the extent of their agreement or disagreement with five opinions about mathematics curricula as far as their specified class was concerned. The results are presented in Table 9-15.

Table 9-15
Responses to Five Curricular Statements
(Percents)

Curricular Statement	Elementary		Secondary	
	NR*	PR	NR	PR
1. Logical structure should be emphasized as a framework for the study of mathematics	2	79	6	78
2. Opportunity must be provided for students to apply mathematics in as wide a realm as possible	2	94	2	89
3. Instructional units dealing with statistics should be included in the curriculum	32	22	20	55
4. Problem solving should be the focus of school mathematics in the 1980s	14	70	8	75
5. Basic skills in mathematics should be defined to encompass more than computational facility	6	80	4	83

*NR--Negative Response, PR--Positive Response.

At least 70% of the teachers responded positively to four of the five mathematics curricular statements listed. The statistics statement was not agreed to by a majority of either group, which is consistent with other data gathered by the questionnaire.

Teachers were presented with a list of 12 mathematical topics which might be a part of any mathematics curriculum. Teachers were first asked to rate each topic with the amount

of emphasis they felt each was currently receiving in the curriculum for their specified classes. Teachers were then asked to rate the same topics with respect to the amount of emphasis they felt each topic should be receiving. The percent of teachers responding Much Emphasis to each topic is presented in Table 9-16.

Table 9-16
Preferred Emphasis on Topics*
(Percent)

Topic	Elementary Is Emphasized	Elementary Should Emphasize	Secondary Is Emphasized	Secondary Should Emphasize
Mathematical concepts	69	73	48	53
Arithmetic skills	90	92	41	50
Algebraic concepts and skills	6	9	62	63
Geometric concepts	4	8	15	26
Consumer mathematics	4	20	13	29
Applications to other fields	3	13	7	22
Structure of number systems and properties	26	30	15	15
Measurement	24	38	10	10
Problem solving	47	70	46	64
Logical thinking	27	50	28	45
Using mathematics to predict	6	16	3	13
Reading, interpreting, and constructing tables and graphs	9	21	13	23

*Percent of teachers responding Much Emphasis

With respect to the current emphasis given each of the twelve topics, there were some expected differences such as on arithmetic skills. Both groups felt arithmetic skills were currently being emphasized in the B. C. mathematics curriculum, but 91% of elementary teachers felt the topic was getting Much Emphasis compared to 41% of secondary teachers. Measurement was felt to be getting Some or Much Emphasis by 90% of elementary teachers compared to only 53% of secondary mathematics teachers. On the other hand, 62% of secondary mathematics teachers felt Algebraic concepts and skills were getting Much Emphasis compared to only 6% of elementary

teachers.

Of more interest to curriculum developers than what teachers perceived to be getting emphasis is what topics teachers want to be emphasized. Elementary teachers differed from secondary teachers on half of the twelve topics. Some differences were expected such as 92% of elementary teachers felt arithmetic skills should receive Much Emphasis compared to only 50% of secondary mathematics teachers (and only 35% of senior secondary mathematics teachers); 18% of the secondary mathematics teachers felt measurement should receive Much Emphasis while 38% of elementary teachers felt that way (and a total of 96% of elementary teachers felt it should receive Some or M ch Emphasis); on the other hand, 63% of secondary mathematics teachers felt algebraic concepts and skills should be receiving Much Emphasis compared to only 9% of elementary teachers.

Some of the other comparisons were not so expected. Only 8% of elementary teachers felt geometric concepts should receive Much Emphasis compared to 26% of secondary mathematics teachers. Only 66% of elementary teachers felt applications to other fields should be receiving Some or Much Emphasis compared to 83% of secondary mathematics teachers. Finally, the proportion of elementary teachers who felt structure of number systems and properties should be receiving Much Emphasis was double the comparable group of secondary mathematics teachers.

Ninety-five percent of teachers felt that problem solving was currently receiving Some or Much Emphasis. The term "problem solving", unfortunately, means different things to different people It is not known what definition of problem solving teachers were using.

Over 75% of teachers felt logical thinking was receiving Some or Much Emphasis. Logical thinking does not appear as an actual topic in the B. C. mathematics curriculum until Grade 8. It is unknown in what manner logical thinking is receiving emphasis. However it is occurring, 90% of teachers felt logical thinking should receive Some or Much Emphasis.

Calculators

The last two items in the Class-Specific Information section of the two questionnaires dealt with the use of calculators in the specified mathematics classes. The only comparison that will be made is the proportion of the two groups of teachers who make use of calculators in their specified mathematics class. Sixty-two percent of secondary mathematics teachers allow their students to use calculators in their mathematics classes compared to 14% of elementary teachers; 51% of secondary mathematics teachers use calcula-

tors themselves in the specified mathematics class compared to 13% of elementary teachers. In Table 9-17 below, the data for the two calculator usage items are organized by teaching level.

Table 9-17
Calculator Usage by Teaching Level
(Percent)

Teaching Level	Used by Students	Used by Teachers
Primary	6	6
Intermediate	20	19
Junior Secondary	49	38
Senior Secondary	87	76

The proportion of teachers allowing their students to use calculators or who were using calculators themselves increases as one goes to higher grade levels. The only group of teachers in which a majority made use of calculators is senior secondary mathematics teachers. A majority of teachers was in favor of allowing junior secondary mathematics students to use calculators in their mathematics classes. Thirty-six percent of elementary teachers were in favor of allowing intermediate students to use calculators, but only 20% allowed students in the specified class to do so. In 1977, 32% of elementary teachers allowed students to use calculators in their mathematics classes. Since 1977 calculators have become much more affordable and more classroom material has been been developed. The 1981 result--only 14% of elementary teachers allow their students to use calculators in class. The proportion of secondary mathematics teachers allowing their students to use calculators in class was also down, but by only 4%.

9.5 Summary

One of the most important parts of the process of teaching mathematics is what actually transpires in the classrooms where mathematics is taught. The results and recommendations presented in Chapter 9 concern instructional practices.

Program Implementation

Over 80% of the teachers had referred to the Guide in the last year and two thirds of the teachers felt it is very influential when selecting the course content they present in their mathematics classes. The teachers had very strong feelings that a curriculum guide should contain many things the current Guide does not, and yet the teachers were split as to whether the current Guide should be revised.

Seventy percent of the teachers felt mathematics should be required of all students beyond Grade 10. Twenty-five percent responded Grade 11 should be the last year mathematics is required of all students and 45% responded Grade 12. As one would suspect over 85% of the teachers felt that mathematics at the secondary level should be taught by specialists. However, 40% of the teachers felt the mathematics in Grades 4-7 should also be taught by specialists.

Calculators and Computers

A majority of the teachers supported student use of calculators at the secondary level, and 90% of the teachers felt that students should be allowed to use calculators in their mathematics classes at some level in their schooling. One puzzling result is that the proportion of elementary teachers allowing their students to use calculators in class is down from 37% in 1977 to 14% in 1981. Also 36% of elementary teachers were in favor of allowing intermediate students to use calculators in class but only 20% actually do so.

Very few elementary teachers have access to a computer while most secondary teachers do. An overwhelming majority of the teachers responded positively to using computers in their classrooms, learning to use micro-computers, and including computer literacy in the curriculum (not just the mathematics curriculum) of B. C.

Assessment and Testing

More secondary teachers of mathematics than elementary teachers had read one or more of the reports of the 1977 Assessment. This should be expected since teaching mathematics represents 25% or less of the workload of 80% of the elementary teachers. However, one third of elementary teachers and almost half of secondary teachers had read one of the 1977 Assessment reports.

Not having read any of the reports is reflected in the result that half of the teachers not knowing if the results and recommendations of the 1977 Assessment had had any impact in certain specified areas. Forty percent of the teachers,

however, did respond that the 1977 Assessment results and recommendations had had impact on their own teaching.

Since the Ministry of Education instigated the Mathematics Achievement Test Project (MAT) because of requests from teachers for valid and reliable mathematics achievement tests linked to the B. C. curriculum, it is not surprising that the MAT tests were the most commonly used tests at the secondary level and second only to the Canadian Test of Basic Skills (CTBS) at the elementary level. The CTBS was the only commercially-produced standardized test used by more than 20% of the elementary teachers; no such test was used by more than 20% of the secondary teachers.

While both the MAT tests and the commercial standardized tests are in use, over 90% of the teachers' first choice for an evaluation technique was teacher-prepared tests The teachers' second choice was teacher observation of student performance.

In response to an item that appeared only on the secondary teachers' questionnaire, a majority of secondary teachers were in favor of there being a mathematics test for placement in university.

Class-Specific Information

The final section of the questionnaire required that each teacher specify one of their mathematics classes and respond to the items with that one class in mind. The average number of students enrolled in each of the specified mathematics classes is less than the average in 1977 for all grade levels. The teachers felt that their specified class was of about the same mathematics ability as other classes at the same grade level, but the teachers also felt that there was a wide range of ability within their specified class.

Class Activities. When the teachers partitioned their last meeting with the specified class using eight listed activities, the most common responses were identical between elementary and secondary teachers. When rating eight other activities based on how frequently, in general terms, their students engaged in each, once again the responses were very similar between secondary and elementary teachers. There was a stronger response by elementary teachers to use of oral work, but a majority of secondary teachers also use oral work often. The one activity on which the two groups of teachers did differ was drill on arithmetic computation. The proportion of elementary teachers responding their students engaged in drill frequently was almost four times greater than secondary teachers.

Evaluation. The data appear to show that almost one third of the elementary teachers had not given any mathematics homework to their specified class. The data definitely show that the major use made of the textbook(s) was to provide exercises for drill and practice. The findings for tests were summarized earlier.

If a student was evaluated as not having fulfilled the mathematics requirements for a specified class, then the elementary teachers felt the student should go to a special class within the school for remedial work. Secondary teachers felt such students should either repeat the course or take a different mathematics course at the same grade level.

Curriculum. The teachers felt the present curriculum was doing an adequate job in meeting the needs of the students in their specified classes. Seventy percent or more of the teachers agreed with four of the five mathematics curricular statements. While 46% of secondary teachers also agreed with the statistics statement, only 22% of elementary teachers did so.

A majority of both groups of teachers felt that arithmetic skills, mathematical concepts, and problem solving should be emphasized in the mathematics curriculum. Elementary teachers also felt logical thinking should be emphasized and secondary teachers felt algebraic concepts and skills should be emphasized.

CHAPTER 10

CONCLUSIONS AND RECOMMENDATIONS

David F. Robitaille

Some of the findings of the 1981 Mathematics Assessment warrant special attention because of their significance to the teaching and learning of mathematics. Moreover, the analysis of the Assessment data has given rise to a number of questions and issues which should be addressed in the near future. The Contract Team, having considered the data in some detail, has reached several conclusions about the state of mathematics in the schools of the province, and has a number of recommendations to make to those whose responsibility it is to ensure that the teaching and learning of mathematics continue to improve.

First and foremost, the overall achievement results are encouraging. They indicate that, for the most part, students are learning the content expected of them. Of the total of 15 domain scores at Grades 4, 8, and 12, nine were rated as either Satisfactory or Very Satisfactory. None was rated as being Weak. Of the five domains at each grade level, Measurement is the cause for most concern since it consistently secured the lowest rating.

The process by which the ratings were reached, however, is a cause for some concern. First of all, and as has been mentioned earlier, the Interpretation Panels had considerable difficulty in judging students' performance on difficult items. In most cases their judgment was based almost solely on the percent of students who obtained the correct answer, with little or no weight being attached to the difficulty of the item concerned. Secondly, the Panels rated performance on all of the non-curricular objectives as Satisfactory because those objectives dealt with content that was unfamiliar to the students. In effect this renders their ratings in those areas almost impossible to use to answer questions about the advisability of adding of those topics to the mathematics curriculum. The Learning Assessment Branch should take steps to alter the interpretation process in order to circumvent these problems in the future.

From the other components of the Assessment, the Contract Team identified a number of areas that seem to be especially significant, Along with the achievement results, they form the basis for the recommendations that are listed below.

On the basis of a project as large as the present one, it would be an easy matter to put forward dozens of recommendations, and the temptation to do so is rather strong. However, in the hopes of seeing most, if not all, of them acted upon it seems prudent to limit the number of recommendations and to include only those which, in the opinion of the Contract Team, are in most urgent need of attention.

The results of the assessment have indicated that student achievement in mathematics is generally satisfactory. There are, however, some areas which, in the opinion of the Contract Team, require additional attention.

Recommendation 1

We recommend that teachers of mathematics give increased attention to the following topics:

- *in primary grades, the concepts of inverse operation, missing addends, re-grouping, subset-set models for fractions, and estimation*
- *in intermediate grades, operations with decimals, numeration (including properties of zero), estimation, and percent*
- *in secondary grades, estimation, operations with decimals, problem-solving, and consumer applications*
- *at all levels, the metric system, perimeter, area, and volume*

Questionnaire results show that the use of calculators and computers, both in school and in the home, is increasing and teachers have not been provided with sufficient assistance for making use of these technological aids.

Recommendation 2

a) We recommend that the Curriculum Development Branch immediately establish a committee to consider how calculators and computers should be used and at what grade levels.

This committee should make recommendations, not only about appropriate uses of calculators and computers, but also about financial implications regarding both hardware and software.

b) We recommend that, based on the recommendations of the above committee, the Curriculum Development Branch develop materials for teaching computer literacy.

In line with the opinions expressed by teachers and members of Review Panels, those materials should be usable in the context of several different courses.

c) We recommend that Program Implementation Services develop appropriate in-service programs to facilitate successful utilization of the above materials at the classroom level.

Results of the Goals Survey and the opinions expressed by members of the Review Panels and by teachers on the Teacher Questionnaires provide valuable guidance for future revision of the mathematics curriculum.

Recommendation 3

a) We recommend that the forthcoming revised mathematics curriculum include among its major goals, the development of student skills in problem-solving, logical thinking, and consumer applications of mathematics; and that the topics of probability and statistics be included as important and identifiable components.

b) We recommend that, in any revision of the mathematics curriculum, the Curriculum Development Branch restructure the Curriculum Guide and Resource Book to include:

- *separate sections of the guide for each grade*
- *minimal content objectives for each grade*
- *suggested order for treating the topics in the course*
- *suggested time allocations for topics*
- *suggestions regarding appropriate methods and materials for teachers to use*

The results of the Teacher Questionnaire indicate that the vast majority of teachers consider that compulsory mathematics to the end of Grade 10 is insufficient.

Recommendation 4

We recommend that all students be required to take some form of mathematics course each year at least from Grade 1 through Grade 11.

In the opinion of the Contract Team, the Teacher Questionnaire results indicate that an unacceptably large number of teachers of mathematics are inadequately prepared, either academically or professionally.

Recommendation 5

a) We recommend that School Boards and Principals attempt to ensure that only persons with academic and professional training in mathematics education are permitted to teach mathematics at either the elementary or the secondary school level.

b) We recommend that all Faculties of Education in the universities of the province of British Columbia include, as a compulsory component for elementary teacher preparation, a course in methods of teaching mathematics.

c) We recommend that Program Implementation Services, with the cooperation of School Boards and Faculties of Education, organize, and provide adequate funding for, in-service programs for the re-training of those teachers who, for whatever reason, have been asked to teach mathematics but do not have the necessary preparation.

From the results of the Teacher Questionnaire, it is evident that teacher-made tests form a substantial component of the evaluative data used by teachers in making decisions about students. It is essential that such instruments be both reliable and valid and that teachers be able to interpret the results of these tests in a professional manner.

Recommendation 6

a) We recommend that the Faculties of Education in the universities of the province of British Columbia ensure that all of their students are exposed to the principles of test construction and analysis of test data as well as to other methods of assessing student performance.

b) We recommend that School Boards organize in-service programs for their teachers on principles of test construction, analysis of test data, and other methods of assessing student performance.

c) We recommend that the Learning Assessment Branch continue developing classroom achievement tests, publishing reference materials for the use of teachers and providing in-service assistance in methods of student evaluation.

There is considerable evidence that the geometry included in the prescribed curriculum is not being taught in all classes and that many teachers do not see geometry as a particularly important part of the curriculum. Moreover, in the 1980/81 school year, only six percent of the Grade 12 students were enrolled in Geometry 12.

Recommendation 7

We recommend that, in the forthcoming revision of the mathematics curriculum, the Curriculum Development Branch determine the place and the role of geometry at all levels of the curriculum.

At the present time, only one percent of elementary teachers belong to the British Columbia Association of Mathematics Teachers.

Recommendation 8

We recommend that the British Columbia Association of Mathematics Teachers take steps to make membership in the B.C.A.M.T. more attractive to teachers of mathematics in the province, especially at the elementary level.

Results from the metric usage items indicate that students do not "think metric", that is, they do not use metric units as their first or most natural response to a measurement situation.

Recommendation 9

We recommend that the Minister of Education alert the Metric Commission of Canada to the fact that students do not "think metric", and request the Metric Commission take action to increase the use of metric units in the media and to educate the public in the use of metric units.

Following the 1977 Mathematics Assessment and the 1978 Science Assessment, a discussion paper entitled Gender and Mathematics/Science Education in Elementary and Secondary Schools, was commissioned by the Ministry of Education. The results of this Assessment indicate no significant change in the rate of participation of females in mathematics courses at the senior secondary level. Moreover, the pattern of differences in achievement between males and females remains unchanged.

Recommendation 10

We recommend that the Minister of Education charge the appropriate sections of his Ministry with examining and, where appropriate, acting upon the recommendations of discussion paper 08/80: Gender and Mathematics/Science Education in Elementary and Secondary Schools.

APPENDIX A

CONTRIBUTORS TO THE REPORT

Ian de Groot is a teacher at Sutherland Secondary School in North Vancouver. He is Vice-President of the North Vancouver Teachers Association and a referee for *The Mathematics Teacher*, published by the National Council of Teachers of Mathematics.

Michael Dirks is a doctoral student in Mathematics Education at U. B. C. He has taught extensively in the United States and in Thailand.

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Thomas O'Shea is an Assistant Professor in the Faculty of Education at Simon Fraser University. He has previously been involved in assessment activities as research assistant on the Mathematics Achievement Test Project and as a representative for B. C. Research on the 1980 Reading Assessment.

David Robitaille is a Professor in the Department of Mathematics and Science Education at the University of British Columbia. He served as chairman of both the 1977 and 1981 Mathematics Assessment Contract Teams, and of the Mathematics Achievement Test Project. He is also co-ordinating B. C. participation in the Second International Study of Mathematics.

James Sherrill is a Professor in the Department of Mathematics and Science Education at the University of British Columbia. He served on both the 1977 and 1981 Mathematics Assessment Contract Teams, as well as on the Mathematics Achievement Test Project for the Ministry of Education. He is currently serving as chairman of the Board of Directors of the Educational Research Institute of British Columbia.

APPENDIX B

MEMBERS OF REVIEW PANELS

Primary Panels

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Heather Kelleher, Teacher, New Westminster School District
John McMaster, Teacher, Trail School District
Ruth Miller, Trustee, Powell River School District
Suzanne Montemuro, Parent, North Vancouver
Ron Popoff, Teacher, West Vancouver School District
Sheila Roberts Teacher, Vancouver Diocese
Elizabeth Robertson, Teacher, Vancouver School District
Doug Super, Coordinator, Richmond School District
Polly Weinstein, University of British Columbia

Intermediate Panels

Richmond

Robert Betts, Teacher, Burnaby School District
Richard Bury, Teacher, Surrey School District
Sr. Helen Danahy, Principal, Vancouver Diocese
Bill Davidson, Teacher, Coquitlam School District
Grace Dilley, Helping Teacher, Surrey School District
Art Fletcher, Superintendent, Lillooet School District
George Ivanisko, Supervisor, Langley School District
Hannu Makinen, Teacher, Delta School District
Robert Rennie, Capilano College
Gail Spitler, University of British Columbia
Bill Wallace, Principal, Burnaby School District

Qualicum

Bob Campbell, Teacher, Victoria School District
Ron Edmonds, Teacher, Victoria School District
Don Frewing, Teacher, Sooke School District
Ted Horn, University of Victoria
Lois Macy, Trustee, Qualicum School District
Mark Mahovolich, Teacher, Saanich School District
Greg Murray, Teacher, Lake Cowichan School District
Peter Smart, Royal Roads College
Walter Tangye, Trustee, Saanich School District
Bill Van Dyke, Principal, Society of Christian Schools
James Wilson, Teacher, Campbell River School District

Secondary Panels

Richmond

Jack Buller, Teacher, Delta School District
Helen Casher, Trustee, Maple Ridge School District
Ken Corbett, Teacher, Richmond School District
Harvey Gerber, Simon Fraser University
Tom Howitz, University of British Columbia
John Klassen, Teacher, North Vancouver School District
George Main, Principal, Langley School District
Wayne Matthews, Teacher, North Vancouver School District
Fil Muaro, Teacher, Grand Forks School District
John Turnbull, Teacher, Richmond School District

Prince George

Doug Cutler, Teacher, Smithers School District
Ken Dick, Principal, Prince George Diocese
Dan Dobrinsky, Teacher, Quesnel School District
Margaret Ernst, Trustee, Quesnel School District
Dave Hamblin, Teacher, Cariboo-Chilcotin School District
Harry Hufty, Coordinator, Prince George School District
Jennifer Johnston, Teacher, Prince George School District
Henry Kuiperi, Teacher, Fort Nelson School District
Clint Lee, College of New Caledonia
Jake Penner, Teacher, Prince George School District
Ed Zolinski, Teacher, Peace River North School District

APPENDIX G

MEMBERS OF INTERPRETATION PANELS

Grade 4

Franca Boratto, Multi-Cultural Worker, Vancouver
Pat Craig, Teacher, Sunshine Coast School District
Margaret Diana, Teacher, Victoria School District
Randolph Gris, Principal, Nelson School District
Irene Macrae, Trustee, Qualicum School District
John Opra, Principal, Revelstoke School District
Ann Peterson, Teacher, Terrace School District
Mark Proctor, Teacher, Vancouver School District
Marilyn Shore, Teacher, Cariboo-Chilcotin School District
Gail Spitler, University of British Columbia
Mary Stewart, Teacher, Richmond School District
Angie Thorn, Teacher, South Cariboo School District
Jean Vallance, Primary Supervisor, Langley School District
Marilyn Wood, Parent, Richmond

Grade 8

Jim Bourdon, Supervisor, North Vancouver School District
Terry Demchuk, Principal, Trail School District
Chris Donaldson, Parent, West Vancouver
John Gordon, Teacher, Delta School District
Pat Henman, Teacher, Abbotsford School District
Tom Howitz, University of British Columbia
Phil Judd, Teacher, Cowichan School District
Ed Kwasniewski, Teacher, Nelson Diocese
Lenore Lawrence, Trustee, Peace River South School District
Les Matthews, Principal, Chilliwack School District
David Miller, Teacher, Qualicum School District
Jack Morrison, Teacher, Prince George School District
Eunice Parker, Trustee, Coquitlam School Board
Jesse Rupp, Teacher, West Vancouver School District
Bill Seaton, Okanagan College

Grade 12

Helen Casher, Trustee, Maple Ridge School Board
John Ciriani, Cariboo College
Lloyd Colling, Supervisor, Nechako School District
Elaine Curling, Teacher, Victoria School District
Margaret Ernst, Trustee, Quesnel School Board
Chester Gris, Teacher, Creston School District
Ted Horn, University of Victoria
David Kennedy, Teacher, Langley School District
Mike Law, Teacher, Lillooet School District
Ray Leung, Teacher, Sooke School District
Art Olsen, Teacher, New Westminster School District
Les Phillips, Teacher, Coquitlam School District
Peter Woolley, Institute of Chartered Accountants
John Worobec, Consultant, Vancouver School Board

APPENDIX D

LIST OF PILOT SCHOOLS

Primary (Grade 4 Items)

Alice Brown Elementary, Langley School District
Arthur Hatton Elementary, Kamloops School District
Bear Creek Elementary, Surrey School District
Birchland Elementary, Coquitlam School District
Burrard View Elementary, North Vancouver School District
Cascade Heights Elementary, Burnaby School District
Charles Dickens Elementary, Vancouver School District
Clinton Elementary, Burnaby School District
Coghlan Elementary, Langley School District
Davie Jones Elementary, Maple Ridge School District
Franklin Elementary, Vancouver School District
Gabriola Elementary, Nanaimo School District
George Jay Elementary, Victoria School District
George Vanier Elementary, Surrey School District
Glenrosa Elementary, Central Okanagan School District
Golden Ears Elementary, Maple Ridge School District
Hastings Elementary, Vancouver School District
James Ardiel Elementary, Surrey School District
James Bay Community Elementary, Victoria School District
Lakewood Elementary, Prince George School District
Latimer Road Elementary, Surrey School District
Lord Strathcona Elementary, Vancouver School District
Malaspina Elementary, Prince George School District
Marigold Elementary, Victoria School District
McCloskey Elementary, Delta School District
Mount Benson Elementary, Nanaimo School District
Mundy Road Elementary, Coquitlam School District
Pitt Meadows Elementary, Maple Ridge School District
Port Guichon Elementary, Delta School District
Ralph Bell Elementary, Kamloops School District
Raymer Elementary, Central Okanagan School District
Shortreed Elementary, Langley School District
Thomas Kidd Elementary, Richmond School District
Thunderbird Elementary, Vancouver School District
University Hill Elementary, Vancouver School District
Walter Moberly Annex Elementary, Vancouver School District
Webber Road Elementary, Central Okanagan School District
Westsyde Elementary, Kamloops School District

Intermediate (Grade 8 Items)

Burnsview Jr. Secondary, Delta School District
Britannia Secondary, Vancouver School District
Cedar Jr. Secondary, Nanaimo School District
City School, Vancouver School District
D.P. Todd Secondary, Prince George School District
Edmonds Jr. Secondary, Burnaby School District
Eric Hamber Secondary, Vancouver School District
Frank Hurt Secondary, Surrey School District
George Pringle Secondary, Central Okanagan School District
Guilford Park Secondary, Surrey School District
Hastings Jr. Secondary, Coquitlam School District
Hollywood Road Secondary, Central Okanagan School District
King George Secondary, Vancouver School District
Lakewood Jr. Secondary, Prince George School District
Lambrick Park Secondary, Victoria School District
L.A. Matheson Secondary, Surrey School District
Mountain Secondary, Langley School District
Montgomery Secondary, Coquitlam School District
Poppy Secondary, Langley School Distict
R.C. Palmer Secondary, Langley School District
Royal Oak Secondary, Burnaby School District
Sutherland Secondary, North Vancouver School District
University Hill Secondary, Vancouver School District
Vancouver Technical, Vancouver School District

Secondary (Grades 10 and 12 Items)

Britannia Secondary, Vancouver School District
D.P. Todd Secondary, Prince George School District
Eric Hamber Secondary, Vancouver School District
Frank Hurt Secondary, Surrey School District
George Pringle Secondary, Central Okanagan School District
Guilford Park Secondary, Surrey School District
Hollywood Road Secondary, Central Okanagan School District
Lambrick Park Secondary, Victoria School District
L.A. Matheson Secondary, Surrey School District
Matthew McNair Secondary, Richmond School District
Mountain Secondary, Richmond School District
R.C. Palmer Secondary, Richmond School District
Poppy Secondary, Langley School District
Royal Oak Secondary, Burnaby School District
University Hill Secondary, Vancouver School District
Westsyde Secondary, Kamloops School District
Sutherland Secondary, North Vancouver School District

APPENDIX E

GOALS SURVEY QUESTIONNAIRE

Second B.C. Mathematics Assessment

One of the major goals of the Second Assessment of Mathematics in British Columbia is to provide information to determine if a revision of the existing mathematics curriculum is needed. To that end, this questionnaire is designed to seek your opinions about a number of questions which are relevant to this matter. The questionnaire is divided into four sections, each one dealing with a major area of concern to the mathematics curriculum. The four sections are:

A. Goals of Mathematics Education
B. Content of the Curriculum
C. Organizing for Instruction
D. Process and Affective Objectives

Your written comments dealing with any or all of the items would be welcome.

A. Goals of Mathematics Education

1.1 Rank the following goals of education (K-12) by writing a number from 1 (most important) to 6 (least important) in the space provided.

____ a. To pass on society's conventional wisdom to a new generation

____ b. To prepare students for the job market

____ c. To prepare students to live in society

____ d. To prepare students for higher education

____ e. To keep students out of the job market until they are at least 16 years old

____ f. To have students acquire basic knowledge such as reading, writing, and mathematics.

1.2 What other goals would you add to the above list?

____

____

____

2.1 Rank the following functions of school mathematics education (K-12) by writing a number from 1 (most important) to 7 (least important) in the space provided.

____ a. To teach students the mathematical concepts and skills required to function as enlightened consumers in a technological society

____ b. To serve as a mechanism for sorting students for entrance into their vocational fields of interest

____ c. To familiarize students with the major ideas and processes used in mathematics

____ d. To prepare students for entry into specialized technological, scientific, and professional fields

____ e. To develop in students the ability to think logically

____ f. To develop students' interest in and enthusiasm for the study of mathematics by introducing them to interesting mathematical topics

____ g. To prepare students for the study of further mathematics.

2.2 What other functions would you add to the above list?

____

____

____

B. Content of the Curriculum

3.1 Below is a list of nine topics which could be included in the elementary mathematics curriculum. How important should each one be at the elementary school level?

	Not Important	Somewhat Important	Very Important	Absolutely Essential
a. mathematical concepts	____	____	____	____
b. arithmetic skills	____	____	____	____
c. algebra	____	____	____	____
d. geometry	____	____	____	____
e. consumer mathematics	____	____	____	____
f. applications to other fields	____	____	____	____
g. structures and properties	____	____	____	____
h. measurement	____	____	____	____
i. problem solving	____	____	____	____

3.2 Below is a list of nine topics which could be included in the secondary mathematics curriculum. How important should each one be at the secondary school level?

	Not Important	Somewhat Important	Very Important	Absolutely Essential
a. mathematical concepts	____	____	____	____
b. arithmetic skills	____	____	____	____
c. algebra	____	____	____	____
d. geometry	____	____	____	____
e. consumer mathematics	____	____	____	____
f. applications to other fields	____	____	____	____
g. structures and properties	____	____	____	____
h. measurement	____	____	____	____
i. problem solving	____	____	____	____

4.1 Below is a list of twelve possible areas for emphasis in school mathematics. How important should each one be at the school level for which your panel is constituted?

	Not Important	Somewhat Important	Very Important	Absolutely Essential
a. Alertness to the Reasonableness of Results	____	____	____	____

Because of arithmetic errors or other mistakes, the results of mathematical work are sometimes wrong. Students should learn to inspect all results and to check for reasonableness in terms of the original problem.

b. Applying Mathematics to Everyday Situations	____	____	____	____

The use of mathematics is interrelated with all computational activities. Students should be able to take everyday situations, translate them into mathematical expressions, solve the mathematics, and interpret the results in the light of the initial situation.

c. Computational Skills	____	____	____	____

Students should gain facility with addition, subtraction, multiplication, and division with whole numbers and decimals. Though long, complicated computations will probably be done with a calculator, students need to know their basic facts, mental arithmetic, simple computation with common fractions, and percent.

d. Computer Literacy	____	____	____	____

Students should be aware of the many uses of computers in society, such as their use in teaching/learning, financial transactions, and information storage and retrieval. The "mystique" surrounding computers should be eliminated.

e. Estimation and Approximation	____	____	____	____

Students should be able to carry out rapid approximate calculations by first rounding off numbers. They should acquire some simple techniques for estimating quantity, length, distance, weight, etc.

f. Geometry	____	____	____	____

Students should learn the geometric concepts they will need to function effectively in the three-dimensional world. They should have knowledge of concepts such as point, plane, parallel, etc. They should know basic properties of simple geometric figures

	Not Important	Somewhat Important	Very Important	Absolutely Essential
g. History of Mathematics	____	____	____	____

Students should know about great mathematicians as people and the processes and procedures they used to develop their areas of mathematics. Students should also know the history of the development of the major strands of mathematics.

h. Measurement	____	____	____	____

Students should be able to measure distance, weight, time, capacity, temperature in metric units. They should also be able to measure angles and calculate simple areas and volumes.

i. Numeration	____	____	____	____

Students should know what is required to create a numbering system. They should study examples of numeration systems and make comparisons to the Hindu-Arabic system.

j. Problem Solving	____	____	____	____

Students must learn to solve problems, including non-textbook problems. They must learn to pose questions, analyze situations, translate results, draw diagrams, use trial and error, determine which facts are relevant, and apply the rules of logic to arrive at valid conclusions. Students must be unfearful of arriving at tentative conclusions and having these conclusion subjected to scrutiny.

k. Reading, Interpreting, and Constructing Tables, Charts, and Graphs	____	____	____	____

Students should know how to read and draw conclusions from simple tables, maps, charts, and graphs. They should be able to condense numerical information into more manageable and meaningful terms by setting up simple tables, charts, and graphs.

l. Using Mathematics to Predict	____	____	____	____

Students should learn how elementary notions of probability are used to determine the likelihood of future events. They should learn to identify situations where immediate past experience does not affect the likelihood of future events. They should become familiar with how mathematics is used to help make predictions such as election forecasts.

4.2 In the first column check the three most important areas at your level, and in the second column check the three least important.

	Most Important	Least Important
a. Alertness to the Reasonableness of Results	____	____
b. Applying Mathematics to Everyday Situations	____	____
c. Computational Skills	____	____
d. Computer Literacy	____	____
e. Estimation and Approximation	____	____
f. Geometry	____	____
g. History of Mathematics	____	____
h. Measurement	____	____
i. Numeration	____	____
j. Problem Solving	____	____
k. Reading, Interpreting, and Constructing Tables, Charts, and Graphs	____	____
l. Using Mathematics to Predict	____	____

5. Consider the present mathematics curriculum in B.C. For each level at which you feel yourself competent to judge, name three topics which you feel should NOT be part of a revised curriculum. The page numbers refer to the 1978 edition of the curriculum guide for mathematics.

5.1 GRADES 1 - 3: Page 10-12

a. ____________________

b. ____________________

c. ____________________

5.2 GRADES 4 - 6: Page 14-19

a ____________________

b. ____________________

c. ____________________

5.3 GRADES 7 - 8: Pages 22-26

a. ____________________

b. ____________________

5.4 GRADES 9 - 10: Pages 28-37

a. ____________________

b. ____________________

c. ____________________

5.5 GRADES 11 - 12: Pages 40-60

a. ____________________

b. ____________________

c. ____________________

6. Consider the present mathematics curriculum in B.C. For each level at which you feel yourself competent to judge, name three topics which you feel should be in a revised curriculum. These topics need not be in the present curriculum. The page numbers refer to the 1978 edition of the curriculum guide for mathematics.

6.1 GRADE 1 - 3: Page 10-12

a. ____________________

b. ____________________

c. ____________________

6.2 GRADE 4 - 6: Pages 14-19

a. ____________________

b. ____________________

c. ____________________

6.3 GRADES 7 - 8. Pages 22-26

a. ____________________

b. ____________________

c. ____________________

6.4 GRADES 9 - 10: Pages 28-37

a. ____________________

b. ____________________

c. ____________________

6.5 GRADES 11 - 12: Pages 40-60

a. ____________________

b. ____________________

c. ____________________

C. Organizing for Instruction

7. Some people have expressed the following opinions concerning the organization of instruction. Other people disagree with these positions. Indicate your agreement or disagreement with each statement by checking the appropriate response.

	Strongly Disagree	Disagree	Agree	Strongly Agree
7.1 Students in secondary school mathematics classes should be streamed according to their vocational choice.	____	____	____	____
7.2 Students in secondary school mathematics classes should be streamed according to their mathematics ability.	____	____	____	____
7.3 Admission to senior elective mathematics courses should be decided competitively on the basis of an entrance examination.	____	____	____	____
7.4 Admission to senior elective mathematics courses should be decided competitively on the basis of grades in previous mathematics courses.	____	____	____	____
7.5 All students, through Grade 10, should follow the same basic mathematics program.	____	____	____	____
7.6 All students should be required to take a mathematics course each year, K - 12.	____	____	____	____
7.7 Students within an elementary school mathematics class should be grouped according to their mathematics ability.	____	____	____	____
7.8 Students at a particular grade level in elementary school should be placed into classes according to their mathematics ability.	____	____	____	____

8. In some countries, secondary school students are permitted to concentrate their studies in one or two subject areas. For example, a student might take as much as 10 - 15 hours a week of mathematics classes.

What would be the advantages and the disadvantages of introducing such a system into the secondary schools of B.C.?

ADVANTAGES: ____________________

DISADVANTAGES: ____________________

9. In B.C., many secondary schools offer mathematics on a semester system. Such a system allows a student to take a mathematics course for half of the school year and no mathematics the other half of the school year.

9.1 What are the main advantages and disadvantages of using such a system at the senior secondary level in B.C.?

ADVANTAGES: ____________________

DISADVANTAGES: ____________________

9.2 What are the main advantages and disadvantages of using such a system at the junior secondary level in B.C.?

ADVANTAGES: ____________________

DISADVANTAGES: ____________________

10. At which grade should some form of mathematics course be required of all students? Check all that apply.

At no grade	____	Grade 5	____	Grade 9	____
Kindergarten	____	Grade 6	____	Grade 10	____
Grade 1	____	Grade 7	____	Grade 11	____
Grade 2	____	Grade 8	____	Grade 12	____
Grade 3	____				
Grade 4	____				

11.1 What are the main advantages and disadvantages of requiring all students to show evidence of having mastered the essential mathematics content of a given course (e.g., by writing an examination) before proceeding to the next higher course? (e.g. the Grade 5 course)

ADVANTAGES: ________________________________

____

____

____

DISADVANTAGES: ________________________________

____

____

____

11.2 At what grade should this evidence required? Check all that apply.

At no level	____	Grade 5	____	Grade 9	____
Kindergarten	____	Grade 6	____	Grade 10	____
Grade 1	____	Grade 7	____	Grade 11	____
Grade 2	____	Grade 8	____	Grade 12	____
Grade 3	____				
Grade 4	____				

11.3 If a student is unsuccessful in the attempt to provide evidence of having mastered the mathematics content of a given grade level, what should happen? The student should: (Check ONE Only)

____ a. Repeat the course

____ b. Repeat the grade.

____ c. Go to a special class within the school for remedial work.

____ d. Go to a special school for remedial work.

____ e. Proceed to the next higher mathematics course with his classmates

____ f. Proceed to the next higher grade level with his classmates

____ g. Not be permitted to take any more mathematics courses.

____ h. Take a difference course at the same grade level (e.g., General Mathematics).

____ i. Other. Please Specify

____

____

____

12. At what level(s) should mathematics be taught by specialists? Check all that apply.

____ At no level

____ Primary

____ Intermediate

____ Junior Secondary

____ Senior Secondary

13. At what level(s) should students be grouped according to ability for placement in mathematics classes? Check all that apply.

____ At no level

____ Primary

____ Intermediate

____ Junior Secondary

____ Senior Secondary

14. At what level(s) should students be permitted to use calculators for mathematics? Check all that apply.

____ At no level

____ Primary

____ Intermediate

____ Junior Secondary

____ Senior Secondary

15. How should the teaching of computer literacy (an explanation of computer literacy can be found on page 3) be handled? Select only one response.

- ___ Computer literacy should not be a part of the curriculum.
- ___ It should be taught as part of the mathematics program.
- ___ It should be taught as part of some other existing program. (e.g., Business Education)
- ___ A separate course in computer literacy should be introduced.
- ___ It should be taught as part of several courses (Science, Accounting, Mathematics, etc.).

D. Process and Affective Objectives

16. The curriculum includes product, process, and affective objectives:

- Product objectives are those which concern the specific topics and content of mathematics, for example, addition of decimals.
- Process objectives go beyond the specific content of the courses. They deal with problem-solving techniques and other abilities which are seen to be outcomes of the study of mathematics
- Affective objectives are those related to the attitudes of students toward mathematics and the confidence of students in their ability to do mathematics.

16.1 The following is a list of process and affective objectives only How important should each one be for the mathematics curriculum of the 1980's?

Students should develop:	Not Important	Somewhat Important	Very Important	Absolutely Essential
a. The ability to analyze and conceptualize problems.	___	___	___	___
b. The ability to apply to apply skills and strategies to new situations.	___	___	___	___
c. The ability to discover patterns and similarities.	___	___	___	___
d. An attitude of curiosity and exploration.	___	___	___	___
e. A number of problem-solving strategies.	___	___	___	___
f. The process of logical reasoning.	___	___	___	___
g. The ability to formulate key questions.	___	___	___	___
h. The ability to gather, organize, and interpret data and communicate results.	___	___	___	___

	Not Important	Somewhat Important	Very Important	Absolute Essential
i. A positive attitude toward mathematics.	___	___	___	___
j. An improved sense of confidence in their ability to use mathematics as a tool to solve real-life problems.	___	___	___	___
k. A sense of enjoyment of mathematics.	___	___	___	___
l. The ability to make intelligent guesses	___	___	___	___
m. The ability to read with comprehension.	___	___	___	___

16.2 What would you add to this list?

___

___

___

4

British Columbia Mathematics Assessment 1981

INSTRUCTIONS

HOW TO MARK YOUR ANSWERS

Put an X in the box beside your answer.

For example: Do you live in Canada?

Yes .... [X]

No .... [ ]

NOTE: ALL RESULTS ARE REPORTED IN PERCENTS ROUNDED TO THE NEAREST WHOLE NUMBER. SOME SCALES DO NOT TOTAL TO 100% DUE TO "NO RESPONSE" AND/OR ROUNDING ERROR.

BACKGROUND INFORMATION

1. Please write your school code number in the boxes on the front cover.

2. When were you born?

Year:	1968 or earlier	0	1
	1969	1	2
	1970	4	3
	1971	33	4
	1972	59	5
	1973 or later	3	6
Month:	January		01
	February		02
	March		03
	April		04
	May		05
	June		06
	July		07
	August		08
	September		09
	October		10
	November		11
	December		12

3. Are you a boy or a girl?

Boy	52	1
Girl	48	2

4. Was English the language you first learned to speak?

Yes	86	1
No	14	2

5. Is English the language usually spoken in your home now?

Yes	89	1
No	10	2

APPENDIX F
GRADE 4 DATA

6. Do you use a calculator at home?

Yes	39	1
No	61	2

7. Do you sometimes use a calculator to do your homework?

Yes	13	1
No	86	2

8. Do you sometimes use a calculator in school?

Yes	4	1
No	96	2

9. Both answers given for the following four questions are correct. If you were asked each question, which one of the two answers comes to your mind first?

1. How much does a bicycle weigh?

About 15 kilograms ...	40	1
About 35 pounds	59	2

2. What is the temperature in this room?

About 70 degrees	38	1
About 20 degrees	61	2

3. How far is it from Prince George to Prince Rupert?

About 700 kilometres..	37	1
About 450 miles	63	2

4. How much gasoline can the gas tank in a large car hold?

About 20 gallons	59	1
About 90 litres	41	2

MATHEMATICS AND MYSELF

This is a scale to measure how you feel about mathematics. Below you will find some statements about mathematics. Read each statement and then CIRCLE the choice which best describes how you feel about it.

EXAMPLE:

SKATING IS A WASTE OF TIME.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree

Please be as honest as possible in rating each statement. There is no correct answer.

---

1. I REALLY WANT TO DO WELL IN MATHEMATICS.

Strongly Disagree[1]	Disagree[2]	Can't Decide[3]	Agree[4]	Strongly Agree[5]
3	1	5	25	65

2. I AM LOOKING FORWARD TO TAKING MORE MATHEMATICS.

Strongly Disagree[1]	Disagree[2]	Can't Decide[3]	Agree[4]	Strongly Agree[5]
5	8	23	36	27

3. I FEEL GOOD WHEN I SOLVE A MATHEMATICS PROBLEM BY MYSELF.

Strongly Disagree[1]	Disagree[2]	Can't Decide[3]	Agree[4]	Strongly Agree[5]
3	3	8	37	49

4. I LIKE TO HELP OTHERS WITH MATHEMATICS PROBLEMS.

Strongly Disagree[1]	Disagree[2]	Can't Decide[3]	Agree[4]	Strongly Agree[5]
6	10	20	41	23

5. IF I HAD MY CHOICE I WOULD NOT LEARN ANY MORE MATHEMATICS.

Strongly Disagree[1]	Disagree[2]	Can't Decide[3]	Agree[4]	Strongly Agree[5]
55	23	11	5	5

6. I REFUSE TO SPEND A LOT OF MY OWN TIME DOING MATHEMATICS.

Strongly Disagree[1]	Disagree[2]	Can't Decide[3]	Agree[4]	Strongly Agree[5]
29	28	18	16	10

7. MATHEMATICS IS HARDER FOR ME THAN FOR MOST PERSONS.

Strongly Disagree[1]	Disagree[2]	Can't Decide[3]	Agree[4]	Strongly Agree[5]
24	31	20	16	8

8. I THINK MATHEMATICS IS FUN.

Strongly Disagree[1]	Disagree[2]	Can't Decide[3]	Agree[4]	Strongly Agree[5]
8	8	15	33	36

A-1

Second Assessment of Mathematics

Grade 4 1981

"ORGANIZATION OF :EST ITEMS"

Objective		Test Items *	Page No.
	Domain 1: Number and Operations		
1.1	Number Concepts and Computation	A: 1,2,3,8,12,21,27,28,31,32,35,38 B: 1,2,4,5,15,23,25,27,28,32,37,46 C: 1,2,8,12,14,17,22,25,31,42,43,46	2-12
1.2	Estimation	A: 13,20,24,36 B: 6,40 C: 15,20,28	13-16
1.3	Fractions and Ratio	A: 6,9,19 B: 13,26,31,34,36 C: 4,7,13,26	17-22
	Domain 2: Geometry		
2.1	Geometric Figures	A: 10,33,46 B: 7,9,44 C: 3,6,39	23-27
2.2	Geometric Relationships	A: 4,7,16,34 B: 3,10,19,38 C: 21,27,32,37	28-33
	Domain 3: Measurement		
3.1	Length, Area, Volume and Mass	A: 17,18,30,39,40,45 B: 18,22,35,39,43,45 C: 10,29,30,33,35,38	34-41
3.2	Time and Temperature	A: 14,29,37,41 B: 14,16,17,33 C: 11,16,18,34	42-46
	Domain 4: Algebraic Topics		
4.1	Number Sentences	A: 5,43,44 B: 12,20,24,29 C: 23,40	47-50
4.2	Graphs	A: 25,26 B: 41,42 C: 36,41	51-54
4.3	Probability *(non-curricular objective)*	A: 22,23,42 B: 8,30 C: 9,19,44,45	55-58
5.0	Domain 5: Computer Literacy *(non-curricular objective)*	A: 11,15 B: 11,21 C: 5,24	59-60

*A = Test Booklet A B = Test Booklet B C = Test Booklet C

DOMAIN 1: NUMBER AND OPERATIONS

OBJECTIVE 1.1: NUMBER CONCEPTS AND COMPUTATION

> *Note: Items with the symbol • are not part of the Curriculum*

1.1.1 A/1. If you had 2 quarters, 1 dime and 3 nickels, how much would you have?

		p-value
75¢	☒	80
70¢	☐	3
65¢	☐	9
85¢	☐	6
I don't know	☐	2

1.1.2 A/2. The 2 in 2645 means

2 hundreds	☐	3
2 thousands	☒	88
2 ones	☐	1
2 millions	☐	5
I don't know	☐	3

1.1.3 A/3. SUBTRACT: 4273 − 2896

2623	☐	11
1377	☒	74
2487	☐	7
1623	☐	2
I don't know	☐	7

1.1.4 A/8. 280 ☐ 450

Which number is greater than two hundred eighty and less than four hundred fifty?

530	☐	8
190	☐	8
480	☐	5
360	☒	66
I don't know	☐	10

OBJECTIVE 1.1: NUMBER CONCEPTS AND COMPUTATION

1.1.5 A/12. 9007 is read as:

		p-value
nine hundred seven	☐	16
ninety-seven	☐	1
nine thousand seven	☒	80
nine thousand seventy	☐	2
I don't know	☐	1

1.1.6 A/21 Choose the set with a star in the third place and a circle in the seventh place

△ ○ ✡ ○ △ ✡ □ ○ △ △	☐	3
✡ △ ○ □ □ △ ✡ ✡ ○ □	☐	4
□ ○ ✡ ○ △ □ ○ ✡ □ ○	☒	81
○ □ ✡ ○ □ △ △ ○ □ ✡	☐	2
I don't know	☐	6

OBJECTIVE 1.1: NUMBER CONCEPTS AND COMPUTATION

1.1.7 A/27. Mr. Brown needs 6218 stamps He already has 3493 How many more stamps does he need?

Answer		p-value
3285	[ ]	20
9711	[ ]	7
3825	[ ]	13
2725	[X]	50
I don't know	[ ]	10

1.1.8 A/28 There are five rows with seven flowers in each row. Twelve of the flowers died How many flowers are left?

Answer		p-value
35	[ ]	6
29	[ ]	5
23	[X]	65
12	[ ]	15
I don't know	[ ]	10

1.1.9 A/31. On Monday, 185 people saw the morning whale shows and 412 people saw the afternoon whale shows How many people saw the whale shows that day?

Answer		p-value
597	[X]	84
697	[ ]	4
327	[ ]	4
373	[ ]	3
I don't know	[ ]	5

1.1.10 A/32. Yesterday, Bella the whale ate a total of 98 fish in three meals She ate 32 fish at the first meal and 25 fish at the second meal. How many fish did she eat for her third meal?

Answer		p-value
66	[ ]	4
41	[X]	63
155	[ ]	11
57	[ ]	14
I don't know.	[ ]	9

OBJECTIVE 1.1: NUMBER CONCEPTS AND COMPUTATION

1.1.11 A/35. 79 = ____

Answer		p-value
70 + 9	[X]	89
7 + 9	[ ]	3
70 + 90	[ ]	2
709	[ ]	1
I don't know	[ ]	6

1.1.12 A/38. 8 tens and 5 ones = ____

Answer		p-value
8105	[ ]	1
805	[ ]	7
58	[ ]	2
85	[X]	87
I don't know	[ ]	2

1.1.13 B/1. Which says three dollars and 26 cents?

Answer		p-value
\$300 26	[ ]	[illegible]
\$ 30 26	[ ]	1
\$ 3 26	[X]	90
\$326 00	[ ]	1
I don't know	[ ]	1

1.1.14 B/2 What is the missing number?

$$24 \times \square = 24$$

Answer		p-value
1	[X]	87
4	[ ]	1
0	[ ]	9
24	[ ]	1
I don't know	[ ]	1

OBJECTIVE 1.1: NUMBER CONCEPTS AND COMPUTATION

A-6

1.1.16 C/4. To check this subtraction, which two numbers would be added?

$$\begin{array}{r} 476 \\ -\ 337 \\ \hline 139 \end{array}$$

		p-value
476 and 337	☐	23
476 and 139	☐	8
337 and 139	☒	49
337 and 476 . . .	☐	5
I don't know. . . .	☐	15

1.1.16 B/5. Find the missing number.

3 tens + 12 ones = ☐ tens + 2 ones

4	☒	52
2	☐	4
3	☐	16
1	☐	8
I don't know. .	☐	20

1.1.17 B/15. The roller coaster has 8 cars with 4 wheels on each car How many wheels are there on the roller coaster?

12 .	☐	8
2	☐	1
32	☒	81
24	☐	7
I don't know .	☐	2

1.1.18 B/23. What digit is in the tens place in the number in the box?

$\boxed{2079}$

2	☐	4
0	☐	12
7	☒	76
9	☐	4
I don't know. . .	☐	4

OBJECTIVE 1.1. NUMBER CONCEPTS AND COMPUTATION

A-7

1.1.19 B/25. Which is an odd number?

		p-value
38	☐	11
45	☒	70
42	☐	5
36	☐	8
I don't know . .	☐	6

1.1.20 B/27. Peter has just finished reading a book that is 232 pages long. He was in a hurry so he skipped 41 pages. How many pages did he read?

191.	☒	72
41.	☐	2
211.	☐	15
291.	☐	6
I don't know	☐	5

1.1.21 B/28. Bob needs 50¢ He returned 6 pop bottles and was paid 5¢ a bottle
How much more money does he need?

45¢	☐	15
39¢.	☐	4
44¢.	☐	2
20¢.	☒	74
I don't know	☐	5

1.1.22 B/32. Which is one more than 399?

3991	☐	11
3919	☐	1
401	☐	2
400	☒	84
I don't know	☐	1

OBJECTIVE 1.1: NUMBER CONCEPTS AND COMPUTATION

A-8

1.1.23 B/37. 42 divided by 6 is:

		p-value
48	☐	3
36	☐	3
7	☒	80
8	☐	8
I don't know	☐	6

1.1.24 B/46. Find the missing number:

$$\begin{array}{r} 4\square \\ +\ 2\,3 \\ \hline 6\,5 \end{array}$$

8	☐	7
2	☒	90
12	☐	1
1	☐	0
I don't know	☐	2

1.1.25 C/1. SUBTRACT

$$\begin{array}{r} 86 \\ -\ 22 \\ \hline \end{array}$$

64	☒	93
68 .	☐	1
54	☐	3
108 .	☐	2
I don't know . . .	☐	1

OBJECTIVE 1.1: NUMBER CONCEPTS AND COMPUTATION

A-9

1.1.26 C/2. ADD:

$$\begin{array}{r} 678 \\ 9 \\ +\ 34 \\ \hline \end{array}$$

		p-value
901	☐	1
991	☐	1
621	☐	5
721	☒	88
I don't know	☐	4

1.1.27 C/8. 10 tens = one ______

million	☐	1
thousand	☐	2
hundred	☒	77
ten	☐	15
I don't know.	☐	5

1.1.28 C/12. What is the remainder in the following division problem?

$$\begin{array}{r} 9 \\ 3\overline{)28} \\ \underline{27} \\ 1 \end{array}$$

28	☐	2
9	☐	7
3	☐	6
1 . . .	☒	73
I don't know . . .	☐	11

1.1.29 C/14. Counting by 10's, the next three numbers are:

780, 790, ☐, ☐, ☐

791, 792, 793 . . .	☐	4
720, 730, 740 . . .	☐	3
800, 810, 820 . . .	☒	89
800, 801, 802 . . .	☐	3
I don't know	☐	2

OBJECTIVE 1.1: NUMBER CONCEPTS AND COMPUTATION

A-10

1.1.30 C/17. Which number says four thousand two hundred sixty-five?

		p-value
42 065	☐	14
5 624	☐	8
40 265	☐	8
4 265	☒	77
I don't know. . . .	☐	1

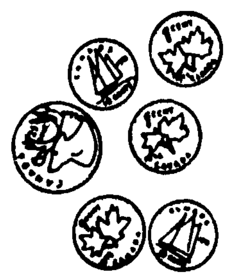
1.1.32 C/25. Which is the smallest number that can be made using all the digits 4, 3, 9, 1?

1934	☐	11
1439	☐	6
1349	☒	70
1943	☐	4
I don't know. . . .	☐	9

1.1.31 C/22. Ernie saved $12.00 to buy stamps for his collection. He bought 6 stamps, at 8¢ each, 8 stamps at 3¢ each, and 5 stamps at 25¢ each. How much did he spend on stamps?

$10.03.	☐	15
$ 0.55.	☐	15
$ 1.97.	☒	45
$13.97.	☐	6
I don't know.	☐	19

1.1.33 C/31. What is the total value of these coins?



43¢	☐	4
38¢	☐	2
75¢	☐	3
48¢	☒	90
I don't know	☐	1

OBJECTIVE 1.1: NUMBER CONCEPTS AND COMPUTATION

A-11

Sam has 51 pop bottles and 8 cartons.
Each carton holds 6 bottles.

1.1.34 C/42. If Sam fills all the cartons, how many bottles will be left over?

		p-value
6	☐	8
8	☐	10
3	☒	42
14	☐	23
I don't know . .	☐	17

1.1.35 C/43. Sam collected 30 of the bottles. His sister, Marie, collected the rest. How many bottles did Marie collect?

18	☐	5
14	☐	9
21	☒	66
44	☐	7
I don't know . .	☐	13

OBJECTIVE 1.1: NUMBER CONCEPTS AND COMPUTATION A-12

1.1.36 C/4b. Jack has written these numbers from left to right. What is Jack doing?

3620	3610	3600	3590	3580

		p-value
Counting backwards by 100's	☐	12
Counting forwards by 100's	☐	5
Counting forwards by 10's.	☐	11
Counting backwards by 10's.	☒	<u>56</u>
I don't know	☐	15

OBJECTIVE 1.2: ESTIMATION A-13

1.2.1 A/13. Round 442 to the nearest hundred.

		p-value
500	☐	17
200	☐	3
600	☐	1
400	☒	<u>76</u>
I don't know. . .	☐	3

1.2.2 A/20. Mr. Fish had 567 hot dogs to sell at the ball game. He had 364 hot dogs left after the game. About how many did he sell?

200	☒	81
600	☐	2
500	☐	2
300	☐	8
I don't know. . .	☐	6

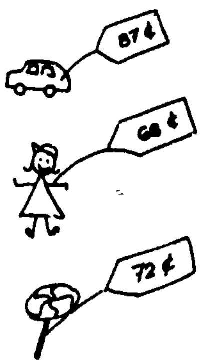
1.2.3 A/24. Round off 43 to the nearest ten.

30 . . .	☐	7
50	☐	8
40	☒	<u>61</u>
44	☐	20
I don't know . .	☐	5

OBJECTIVE 1.2: ESTIMATION

A-14

1.2.4 A/36. If you round the prices of these items to the nearest 10, which two would cost the same?



	p-value
car and doll	5
doll and lollipop. .	☒ 48
lollipop and car . .	11
no two would cost the same	23
I don't know	13

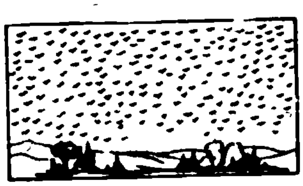
$$3900 + \square = 6000$$

1.2.5 B/6. Which one of the following is CLOSEST to the number that goes in the box?

1000	5
2000	☒ 40
3000	30
5000	17
I don't know . . .	8

OBJECTIVE 1.2: ESTIMATION

A-15



1.2.6 B/40. This is a picture of birds flying south for the winter About how many birds are in the picture? Do not try to count them.

	p-value
20	1
200	☒ 65
500	21
1000	10
I don't know	2

1.2.7 C/15. Round 1368 to the nearest hundred

1300	34
1400	☒ 50
3000	2
2000	7
I don't know	7

1.2.8 C/20. A hippo weighs 1153 kg, an elephant weighs 1127 kg, a moose weighs 1196 kg, and a giraffe weighs 1183 kg. Rounding to the nearest 100 kg, which weighs closest to 1100 kg?

hippo	4
elephant.	☒ 78
moose	9
giraffe	5
I don't know . . .	3

OBJECTIVE 1.2: ESTIMATION A-16

1.2.9 C/28. 156 rounded to the nearest 10 is:

		p value
160	☒	<u>54</u>
150	☐	24
170	☐	5
140	☐	11
I don't know.	☐	7

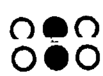
OBJECTIVE 1.3: FRACTIONS AND RATIO A-17

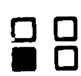
1.3.1 P/6. Jake had 6 baseball cards.
He gave ½ of them away.
How many did he give away?

		p-value
4	☐	7
3	☒	<u>70</u>
2	☐	9
1.	☐	8
I don't know. .	☐	5

1.3.2 A/9. Which set is one-third ($\frac{1}{3}$) shaded?

 . . . . ☐ 1

 . . . ☒ <u>10</u>

 . . . . ☐ 40

 . . . . ☐ 42

I don't know . . . . ☐ 6

OBJECTIVE 1.3: FRACTIONS AND RATIO

1.3.3 A/19.

Children	1	2	3	4	5
Cookies	3	6	9	12	?

The chart shows how many cookies are needed when different numbers of children have three cookies each. For one child, we need three cookies, for two children, six cookies, and so on. What number belongs in the box where you see the question mark?

p-value

20 . . . . . . ☐ 4

15 . . . . . . ☒ 80

13 . . . . . . ☐ 4

10 . . . . . . ☐ 5

I don't know . ☐ 8

1.3.4 B/13. If 10 pencils sold for 90¢, what would 5 pencils cost?

85¢ . . . . . . ☐ 14

65¢ . . . . . . ☐ 8

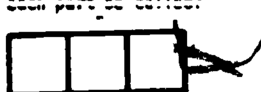
45¢ . . . . . . ☒ 59

25¢ . . . . . . ☐ 10

I don't know. . ☐ 8

OBJECTIVE 1.3: FRACTIONS AND RATIO

1.3.5 B/26. All of the parts of the figure below are the same size. What would each part be called?



p-value

One-fifth . . . ☐ 2

One-fourth. . . ☐ 4

one-third . . . ☒ 79

one-half. . . . ☐ 8

I don't know. . ☐ 6

1.3.6 B/31. Betty cut her cake into two parts of the same size. What is each part called?

$\frac{1}{5}$ . . . . ☐ 4

$\frac{1}{4}$ . . . . ☐ 4

$\frac{1}{3}$ . . . . ☐ 3

$\frac{1}{2}$ . . . . ☒ 85

I don't know. . ☐ 4

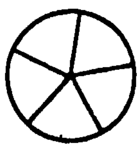
OBJECTIVE 1.3: FRACTIONS AND RATIO

1.3.7 B/34. Which group of dots is one-half ($\frac{1}{2}$) shaded?

I don't know

p-value	22	☒ 57	11	2	8

1.3.8 B/36. George, Mary and Henry decided to eat the pie shown below. George and Mary each ate two pieces. What fraction of the pie was left for Henry to eat?



one-half ($\frac{1}{2}$) . . . . ☐ 17

one-third ($\frac{1}{3}$). . . . ☐ 25

one-fourth ($\frac{1}{4}$) . . . ☐ 10

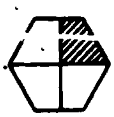
one-fifth ($\frac{1}{5}$). . . . ☒ 42

I don't know . . . . ☐ 6

OBJECTIVE 1.3: FRACTIONS AND RATIO

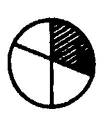
1.3.9 C/6. Which shows $\frac{1}{4}$ shaded?

p-value



☒ 67

☐ 8



☐ 7

☐ 5

I don't know ☐ 10

1.3.10 C/7. If one child needs 2 socks, how many socks do three children need?

3 . . . . ☐ 1

6 . . . . ☒ 95

8 . . . . ☐ 2

9 . . . . ☐ 2

I don't know. . ☐ 1

OBJECTIVE 1.3: FRACTIONS AND RATIO

A-22

1.3.11 C/13.

Eight cars are in a traffic jam. $\frac{1}{4}$ of the cars are new. How many cars are new?

		p-value
1	☐	12
2	☒	<u>27</u>
3	☐	11
4	☐	41
I don't know. . . .	☐	9

1.3.12 C/26. Which box is one-fifth ($\frac{1}{5}$) shaded?


☐ 6


☒ <u>70</u>


☐ 8


☐ 11

I don't know
☐ 5

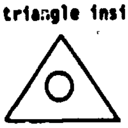
DOMAIN 2: GEOMETRY

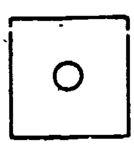
A-23

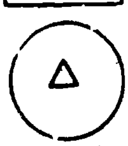
OBJECTIVE 2.1: GEOMETRIC FIGURES

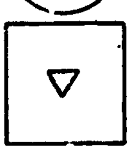
2.1.1 A/10. Which is a picture of a triangle inside a circle?

p-value


☐ 12

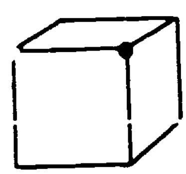

☐ 1


☐ <u>86</u>


☐ 1

I don't know ☐ 1

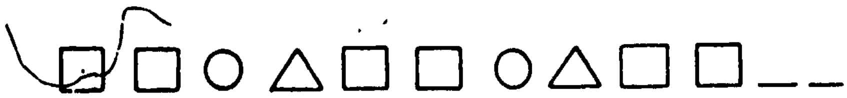
2.1.2 A/33. A dot is on one of the corners of this cube. How many corners does the cube have?



4	☐	9
6	☐	7
7	☐	21
8	☒	<u>62</u>
I don't know. . .	☐	1

OBJECTIVE 2.1 GEOMETRIC FIGURES A-24

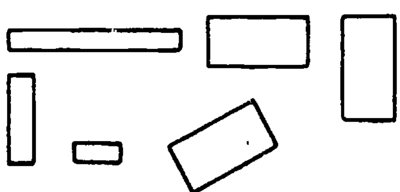
2.1.3 A/46. Complete the pattern. Which comes next?



		p-value
circle, triangle	☒	<u>85</u>
circle, square	☐	3
triangle, circle	☐	3
square, circle	☐	5
I don't know	☐	4

OBJECTIVE 2.1 GEOMETRIC FIGURES A 25

2.1.4 B/7. Each of these shapes is a:



		p-value
rectangle.	☒	<u>84</u>
triangle	☐	2
square	☐	6
line	☐	3
I don't know . . .	☐	2

2.1.5 B/9. The corner of this page is a square corner. How many square corners does a rectangle have?

1	☐	1
2	☐	7
4	☒	<u>86</u>
6	☐	2
I don't know . .	☐	3

2.1.6 B/44. A soup can is shaped most like a:

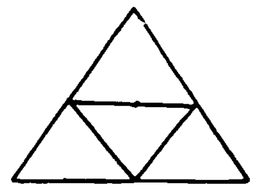
sphere	☐	15
cube	☐	10
cylinder	☒	<u>51</u>
cone	☐	12
I don't know . .	☐	11

OBJECTIVE 2.1 GEOMETRIC FIGURES A-26

2.1.7 C/3. If you connected these three dots with straight lines, what shape would you get?

		p-value
square	☐	1
rectangle. . . .	☐	12
triangle	☒	<u>83</u>
circle	☐	1
I don't know . .	☐	3

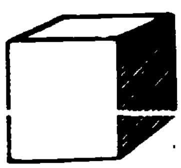
2.1.8 C/6. How many triangles are shown here?



1	☐	6
3	☐	21
5	☒	<u>62</u>
9	☐	3
I don't know. .	☐	8

OBJECTIVE 2.1: GEOMETRIC FIGURES A-27

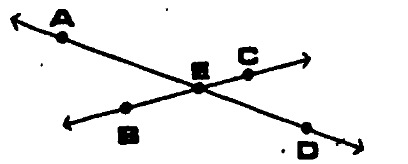
2.1.9 C/39. One face is shaded on this cube. How many faces does the cube have?



		p-value
3	☐	21
6	☒	<u>73</u>
8	☐	3
12	☐	1
I don't know . . .	☐	2

OBJECTIVE 2.2: GEOMETRIC RELATIONSHIPS A-28

2.2.1 A/4. What point is the intersection of the two lines below?



p-value

- B . . . . ☐ 3
- C . . . . ☐ 3
- D . . . . ☐ 8
- E . . . . ☒ 60
- I don't know. . ☐ 24

2.2.2 A/7. Which one of these figures does NOT have a line of symmetry?

 ☐ 2

 ☐ 57

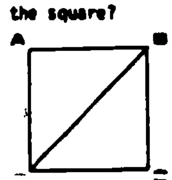
 ☒ 13

 ☐ 9

I don't know ☐ 19

OBJECTIVE 2.2: GEOMETRIC RELATIONSHIPS A-29

2.2.3 A/16. Which segment is not a side of the square?



p-value

- AB . . . . ☐ 5
- BC . . . . ☐ 5
- CD . . . . ☐ 5
- BD . . . . ☒ 72
- I don't know . . ☐ 14

2.2.4 A/34. Triangles that are the same size and shape are <u>congruent triangles</u>.
Which triangle is congruent to this triangle? 

 ☐ 4

 ☒ 53

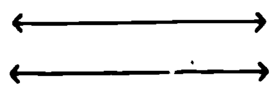
 ☐ 30

 ☐ 3

I don't know ☐ 9

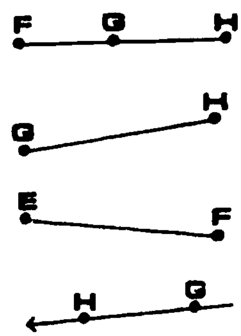
OBJECTIVE 2.2: GEOMETRIC RELATIONSHIPS A-30

2.2.5 D/3. These two lines:



		p-value
intersect	☐	10
form an angle	☐	5
form a square	☐	2
are parallel	☒	56
I don't know.	☐	26

2.2.6 B/10. Which figure has G and H as its end points?



☐ 7

☒ 75

☐ 1

☐ 13

I don't know ☐ 4

OBJECTIVE 2.2: GEOMETRIC RELATIONSHIPS A-31

2.2.7 B/19. Which figure is symmetric?

p-value

☐ 17

☐ 21

☒ 15

☐ 11

I don't know ☐ 35

2.2.8 B/38. Bill is setting the table for his mother. He wants the table to look nice. He uses glasses that are alike. Tell which [illegible] he used.

A, B and C	☐	3
A, D and F	☐	3
B, C and D	☐	3
B, C and E	☒	88
I don't know	☐	2

A-32

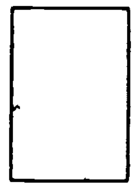
OBJECTIVE 2.2: GEOMETRIC RELATIONSHIPS

2.2.9 C/21. In which figure are all the angles the same size?

p-value

- ☐ 2
- ☐ 5
- ☐ 7
- ☐ <u>69</u>
- I don't know ☐ 15

2.2.10 C/27. How many lines of symmetry does this shape have?

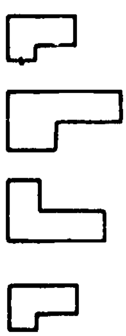


- 1 . . . . ☐ 1
- 2 . . . . ☒ <u>14</u>
- 3 . . . . ☐ 1
- 4 . . . . ☐ 74
- I don't know. . ☐ 10

OBJECTIVE 2.2: GEOMETRIC RELATIONSHIPS

A-33

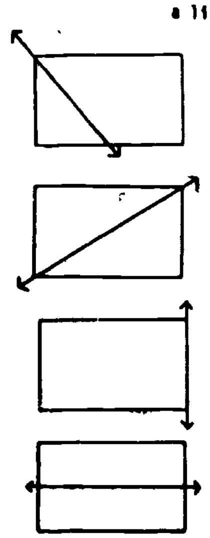
2.2.11 C/32. Figures that are the same size and shape are <u>congruent figures</u>. Which of the following are congruent?



p-value

- A and B . . . . ☐ 5
- A and D . . . . ☒ <u>76</u>
- C and D . . . . ☐ 2
- B and C . . . . ☐ 5
- I don't know. . ☐ 12

2.2.12 C/37. In which figure is the line a line of symmetry?

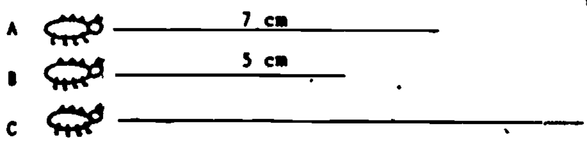


- ☐ 3
- ☐ 18
- ☐ 22
- ☒ 31
- I don't know ☐ 26

DOMAIN 3: MEASUREMENT

OBJECTIVE 3.1: LENGTH, AREA, VOLUME AND MASS

3.1.1 A/17. Three insects travelled along the ground. Insect C travelled twice as far as insect B. How much farther did insect C travel than insect A?



		p-value
10 cm	☐	26
5 cm	☐	10
12 cm	☐	11
3 cm	☒	47
I don't know.	☐	6

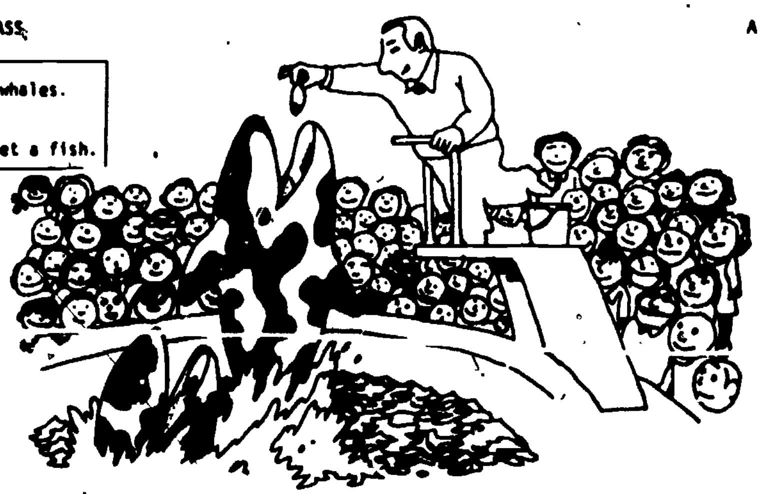
3.1.2 A/18. Which of the metric units listed below is used to measure the amount of water in a pail?

the metre	☐	5
the cubic metre . .	☐	4
the centimetre. . .	☐	6
the litre	☒	76
I don't know. . . .	☐	9

OBJECTIVE 3.1: LENGTH, AREA, VOLUME AND MASS

3.1.3 A/30.

Bella and Dana are killer whales.
They live in an aquarium.
Here is Bella jumping to get a fish.



Bella can jump 627 centimetres high. Dana can jump 5 metres high. How much higher can Bella jump than Dana?

		p-value
127 centimetres .	☒	32
622 centimetres .	☐	24
22 centimetres .	☐	16
632 centimetres .	☐	7
I don't know. . .	☐	22

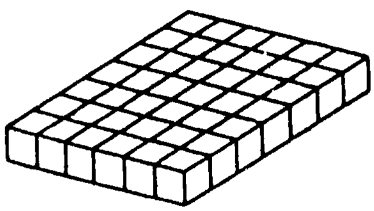
OBJECTIVE 3.1: LENGTH, AREA, VOLUME AND MASS

A-36

3.1.4 A/39. A ten-year-old boy is likely to weigh:

		p-value
35 grams	☐	7
75 grams	☐	18
25 kilograms . .	☒	20
75 kilograms . .	☐	40
I don't know . .	☐	14

3.1.5 A/40. What is the volume of the figure?



1 cubic unit

42 cubic units . . .	☒	81
13 cubic units . .	☐	2
26 cubic units .	☐	2
55 cubic units . . .	☐	6
I don't know	☐	9

3.1.6 A/45. 5 cm is the same as how many millimetres?

500	☐	16
1000	☐	3
50	☒	63
5000	☐	4
I don't know	☐	14

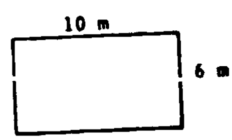
OBJECTIVE 3.1: LENGTH, AREA, VOLUME AND MASS

A-37

3.1.7 B/18. About how far is it from A to B?

		p-value
10 cm	☒	78
5 cm	☐	9
5 mm	☐	3
10 mm	☐	7
I don't know.	☐	4

3.1.8 B/22. What is the DISTANCE ALL THE WAY AROUND this rectangle?

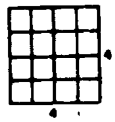


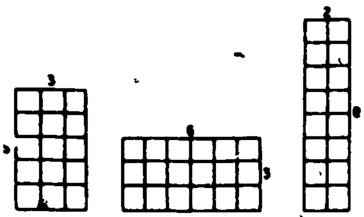
16 m	☐	20
32 m	☒	60
36 m	☐	5
60 m	☐	10
I don't know	☐	5

A-38

OBJECTIVE 3.1: LENGTH, AREA, VOLUME AND MASS

3.1.9 B/35. Which one of the three figures below has the same area as the figure on the right?





			I don't know
☐	☐	☒	☐
p-value 23	7	<u>53</u>	16

3.1.10 B/39. 5 metres is the same length as:

50 centimetres. .	☐	25
500 centimetres. .	☒	<u>47</u>
50 millimetres. .	☐	9
500 millimetres .	☐	4
I don't know . . .	☐	14

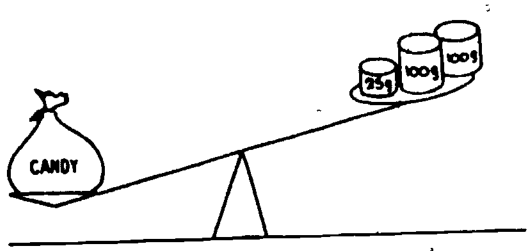
3.1.11 B/43. A paper clip would weigh about:

1 g	☒	<u>87</u>
10 g	☐	8
100 g	☐	1
1000 g	☐	•
I don't know	☐	3

A-39

OBJECTIVE 3.1: LENGTH, AREA, VOLUME AND MASS

3.1.12 B/45. How much does the bag of candy weigh?



		p-value
225 g	☐	27
more than 225 g . . .	☒	<u>46</u>
less than 225 g . . .	☐	7
225 kg.	☐	10
I don't know.	☐	9

3.1.13 C/10 Which unit should be used to measure the length of a house?

millimetres	☐	12
centimetres . . .	☐	6
metres	☒	<u>60</u>
kilometres.	☐	14
I don't know.	☐	8

3.1.14 C/29. Mr. Jones put a wire fence all the way around his rectangular garden. The garden is 10 m long and 6 m wide. How many metres of fencing did he use?

16 m	☐	60
32 m	☒	<u>12</u>
36 m	☐	4
60 m	☐	17
I don't know	☐	8

OBJECTIVE 3.1 LENGTH, AREA, VOLUME AND MASS A-40

3.1.15 C/30. How many centimetres are in one metre?

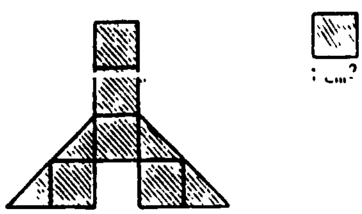
		p-value
1	☐	2
10	☐	14
100	☒	67
1000	☐	10
I don't know	☐	6

3.1.16 C/33 About how long is this crayon?

1 centimetre . .	☐	3
10 centimetres. .	☒	87
1 metre.	☐	4
10 metres	☐	3
I don't know. . .	☐	3

OBJECTIVE 3.1: LENGTH, AREA, VOLUME AND MASS A 41

3.1.17 C/35. What is the area of this shape in square centimetres?



		p-value
7 cm^2	☒	48
12 cm^2	☐	9
9 cm^2	☐	10
5 cm^2	☐	17
I don't know	☐	16

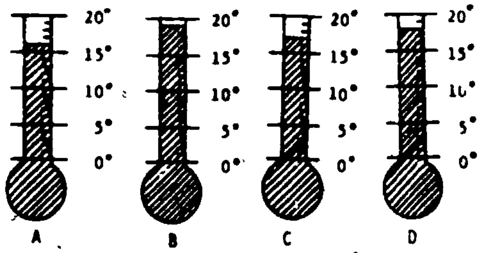
3.1.18 C/38. A milk jug is likely to hold:

1 millilitre	☐	5
10 millilitres	☐	[illegible]
1 litre	☒	83
100 litres . .	☐	4
I don't know . . .	☐	3

OBJECTIVE 3.2: TIME AND TEMPERATURE

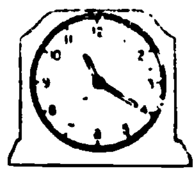
A-42

3 2.1 A/14. Which thermomometer shows 17°?



	p-value	
A	☐	10
B	☐	6
C	☒	65
D	☐	8
I don't know. .	☐	12

3.2.2 A/2? What time does this clock show?



11:20	☒	90
4:00	☐	1
11:40 . . .	☐	7
12 20 . . .	☐	2
I don't know.	☐	1

OBJECTIVE 3.2· TIME AND TEMPERATURE

A-43

3 2.3 A/37. About how long is the time between Halloween and Christmas ?

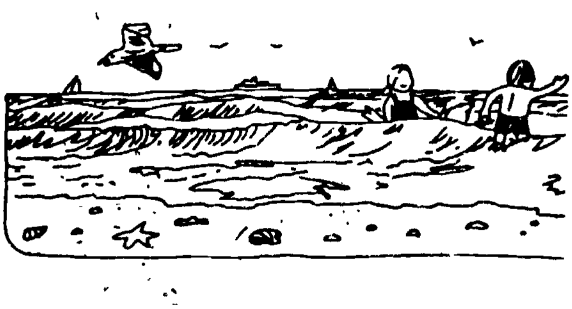
	p-value	
2 months.	☒	78
30 days	☐	8
2 weeks	☐	2
1 year.	☐	8
I don't know.	☐	5

3.2.4 A/41. The temperature on a sunny summer day would most likely be:

5° Celsius . . .	☐	4
25° Celsius . . .	☒	26
55° Celsius . . .	☐	27
85° Celsius . . .	☐	34
I don't know. .	☐	10

3 2 5 B/14. Funland opened on May 16. Jerry and Teresa were there one week later. On what date were they there?

May 17 .	☐	5
May 21 . .	☐	
May 22 . . .	☐	7
May 23	☒	79
I don't know . .	☐	2



A-44

OBJECTIVE 3.2: TIME AND TEMPERATURE

3.2.6 B/16. Teresa and Jerry played Bingo from 4:25 p.m. until 5:00 p.m. For how many minutes did they play Bingo?

		p-value
95	☐	7
25	☐	10
35	☒	55
75	☐	22
I don't know . .	☐	5

3.2.7 B/17. The thermometer reads 30° C. It would be a good day to:

turn on the furnace . .	☐	11
wear a sweater. . . .	☐	15
wear shorts	☒	52
stay in out the cold.	☐	10
I don't know.	☐	12

3.2.8 B/33 It is springtime and the first flowers are blooming. The temperature is most likely between:

-5°C and 0°C	☐	6
15°C and 20°C. . .	☒	37
40°C and 45°C. . .	☐	21
50°C and 55°C . .	☐	17
I don't know . . .	☐	18

OBJECTIVE 3.2: TIME AND TEMPERATURE

A-45

3.2.9 C/11. Jane finished her homework at 7:45. Which clock shows this time?

p-value

 . . . . ☒ 70

 . . . . ☐ 16

 . . . . ☐ 3

 . . . . ☐ 7

I don't know . . . . ☐ 3

3.2.10 C/16. It was a cold, rainy day. When Tom looked at the thermometer it showed:

23° C	☐	7
14° C . . .	☐	10
3° C	☒	52
19° C	☐	18
I don't know. . .	☐	13

3.2.11 C/18. Which says half past two?

30:2	☐	13
230.	☐	7
2:30	☒	69
2.30	☐	7
I don't know . . .	☐	4

OBJECTIVE 3.2: TIME AND TEMPERATURE A-46

3.2.12 C/34 What temperature does this thermometer show?

		p-value
20°	☐	1
17°	☒	<u>81</u>
23°	☐	2
15°	☐	15
I don't know. . . .	☐	1

DOMAIN 4: ALGEBRAIC TOPICS A-47

OBJECTIVE 4.1: NUMBER SENTENCES

4.1.1 A/5. To find the missing number in 746 + ☐ = 931 you should:

		p-value
subtract 746 from 931	☒	<u>42</u>
add 746 to 931.	☐	12
subtract 931 from 746	☐	25
add 931 to 746. . . .	☐	4
I don't know.	☐	16

4.1.2 A/43. Bill had 148 hockey cards and his brother had 87 hockey cards. Which of the equations below could be used to find out how many hockey cards the two boys had together?

148 - 87 = n	☐	16
n + 87 = 148	☐	5
148 + 87 = n	☒	<u>67</u>
148 - n = 87	☐	3
I don't know	☐	10

A-48

OBJECTIVE 4.1: NUMBER SENTENCES

4.1.3 A/44. What sign is missing?

6 ☐ 4 + 3 = 5

		p-value
+	☐	14
-	☒	66
x	☐	3
÷	☐	6
I don't know. .	☐	12

4.1.4 B/12. Choose the missing number.

207 > ☐ > 198

188	☐	14
203	☒	29
209	☐	14
197	☐	15
I don't know. .	☐	28

4.1.5 B/20. Find the missing number.

407 < ☐

399 . . .	☐	11
470	☒	54
407	☐	9
307	☐	13
I don't know. . .	☐	12

A-49

OBJECTIVE 4.1: NUMBER SENTENCES

4.1.6 B/24. Susan's mother gave her 16 m of cloth. Susan used 11 m of the cloth. Which of the equations below could be used to find out how much cloth Susan had left?

		p-value
$n + 6 = 11$ . . .	☐	5
$11 + 6 = n$ . . .	☐	5
$n - 16 = 11$ . . .	☐	7
$16 - 11 = n$ . . .	☒	71
I don't know . . .	☐	11

4.1.7 B/29. Choose the correct symbol to make this a true sentence.

13 ☐ 6

>	☒	77
=	☐	2
<	☐	13
≤	☐	1
I don't know. . .	☐	7

OBJECTIVE 4.1: NUMBER SENTENCES

A-50

4.1.8 C/23. Which number or numbers can go in the $\square$, to make this number sentence TRUE?

$5 + \square < 12$

		p-value
7	☐	66
any number less than 7	☒	<u>20</u>
any number greater than 7	☐	6
no number	☐	2
I don't know	☐	6

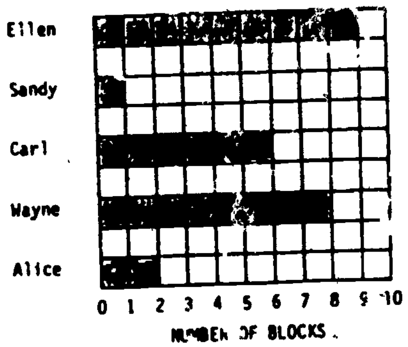
4.1.9 C/40. Which is true?

35 = 30 + 5	☒	<u>67</u>
35 > 30 + 5	☐	3
35 > 5 + 30.	☐	3
30 + 5 < 35.	☐	20
I don't know.	☐	7

OBJECTIVE 4.2. GRAPHS

A-51

Distance Between Home and School



4.2.1 A/25. How far away from school is Wayne's house?

		p-value
2 blocks	☐	11
4 blocks	☐	1
6 blocks	☐	2
8 blocks	☒	<u>84</u>
I don't know	☐	3

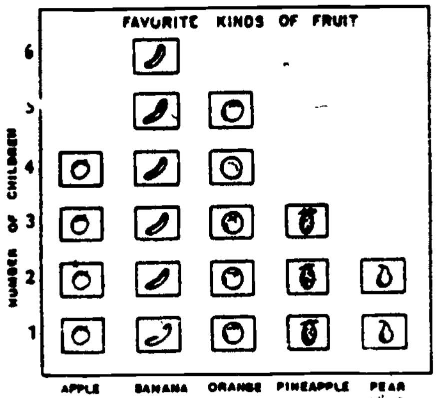
4.2.2 A/26. How much farther from school is Ellen's house than Alice's house?

9 blocks	☐	15
8 blocks	☐	8
7 blocks	☒	<u>69</u>
6 blocks	☐	5
I don't know	☐	3

OBJECTIVE 4.2: GRAPHS

A-52

4.2.3 How many more children chose the
9/41. banana than chose the pear?



		p-value
4	☒	73
2	☐	8
5	☐	10
3	☐	3
I don't know.	☐	6

4.2.4 How many children were in the group that
B/42. made the graph?

20	☒	57
15	☐	7
5	☐	18
30	☐	3
I don't know	☐	15

OBJECTIVE 4.2: GRAPHS

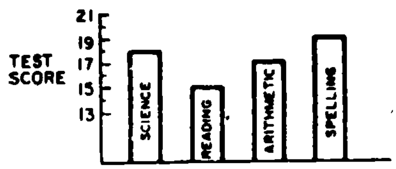
A-53

4.2.5 C/36. Leslie's test scores were:

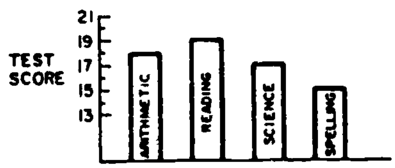
Arithmetic	18
Spelling	15
Science	17
Reading	19

Which graph shows Leslie's results?

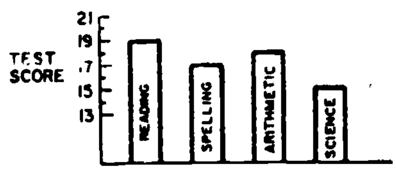
p-value



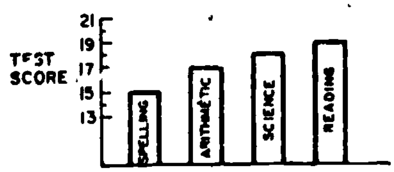
☐ 5



. . . ☒ 58



. . . ☐ 7

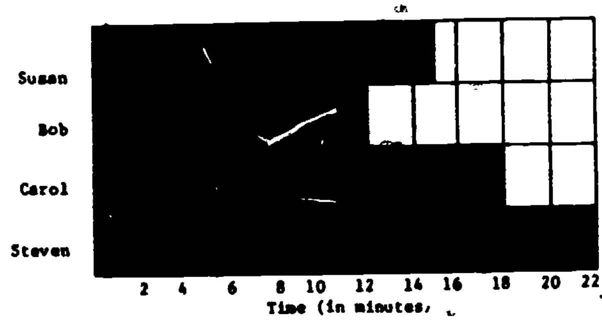


. . . ☐ 9

I don't know . . . ☐ 18

OBJECTIVE 4.2: GRAPHS A-54

4.2.6 C/41.



Pat was testing his model plane. His friends guessed how long it would stay in the air. The plane stayed up for 17 minutes. Who guessed closest to the correct time?

		p-value
Carol	☒	60
Susan	☐	17
Bob	☐	4
Steven	☐	15
I don't know	☐	4

OBJECTIVE 4.3: PROBABILITY *(non-curricular objective)* A-55

4.3.1 *A/22. The chances that lightning will strike your school are:

		p-value
certain	☐	9
very good	☐	5
very unlikely	☒	66
impossible	☐	13
I don't know	☐	7

4.3.2 *A/23. A boy has ten socks in a drawer in a very dark room. Six socks are black and four socks are blue. What is the smallest number of socks he would have to pick to be sure of getting two of the same color?

2	☐	42
3	☒	14
5	☐	9
6	☐	19
I don't know	☐	16

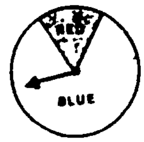
A-56

OBJECTIVE 4.3: PROBABILITY *(non-curricular objective)*

4.3.3 *A/42. Ms. Smith and Mrs. Harris are the only Grade 5 teachers in a school. Ms. Smith's class always has arithmetic first thing in the morning. Mrs. Harris's class sometimes has arithmetic and sometimes has reading first in the morning. If you are in Grade 5 in that school:

		p-value
you will have arithmetic first	☐	21
you will have reading first.	☐	11
you will probably have arithmetic first	☒	40
you will probably have reading first.	☐	15
I don't know	☐	13

4.3.4 *B/8 Sam and Sara are playing a game with this spinner. Every time the spinner lands on red, Sara gets a point. Every time the spinner lands on blue, Sam gets a point. After 10 spins, the winner will be the one with the most points. Who is more likely to win?

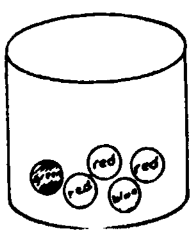


Sara will	☐	8
Sam will.	☒	56
It will be a tie.	☐	9
Either one has the same chance of winning . . .	☐	24
I don't know.	☐	4

A-57

OBJECTIVE 4.3: PROBABILITY

4.3.5 *B/30. A jar contains 3 red marbles, 1 green one, and 1 blue one. If you picked 1 marble from the jar without looking, which colour would you most likely get?

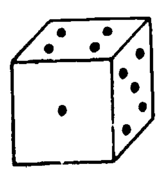


		p-value
green	☐	1
blue	☐	4
red	☒	78
you cannot tell . . .	☐	15
I don't know.	☐	1

4.3.6 * C/9. A jar contains 2 blue pens, 4 red ones and 1 black one. Brad could not decide whether he wanted a red pen or a blue pen. He closed his eyes and picked one from the jar. Which colour is he likely to pick?

blue or black . . .	☐	7
red	☒	60
blue.	☐	16
black	☐	8
I don't know.	☐	9

4.3.7 * C/19. If you tossed one die, what number would show up?



1, 2 or 3	☐	3
6	☐	3
an even number. . . .	☐	8
any number from 1 to 6.	☒	79
I don't know.	☐	7

OBJECTIVE 4.3: PROBABILITY A-58

4.3.8* C/44. The chances that it will snow in Victoria in July are:

		p-value
certain	☐	6
very good	☐	10
very unlikely	☒	38
impossible	☐	38
I don't know	☐	9

4.3.9* C/45. If you toss a coin, which way is it most likely to land?

heads or tails are equally likely	☒	62
tails	☐	9
heads	☐	17
on its edge	☐	4
I don't know	☐	8

DOMAIN 5: COMPUTER LITERACY

A-59

OBJECTIVE 5.0 *(non-curricular objective)*

5.0.1* A/11. In order to solve a problem, a computer:

		p-value
must use punched cards	☐	21
must have a set of instructions written by people	☒	34
must have solved a similar problem before	☐	19
must have blinking lights	☐	8
I don't know	☐	19

5.0.2 *A/15. Computers are:

big	☐	10
noisy	☐	5
many different shapes and sizes	☒	65
heavy	☐	15
I don't know	☐	5

5.0.3 *B/11. Computers are used by:

some libraries	☐	3
many businesses	☐	55
the government	☐	13
all of the above	☒	22
I don't know	☐	7

A-60

OBJECTIVE 5.0 *(non-curricular objective)*

5.0.4* B/21 People would NOT use a computer:

		p-value
to find the sum of a column of numbers	☐	14
to keep track of school records	☐	11
to decide the winner of a football game	☒	39
to put a list of names in alphabetical order	☐	27
I don't know	☐	9

5.0.5* C/5. Computers are used:

by many different kinds of people	☒	56
only by scientists	☐	4
only by very smart people	☐	3
only by big institutions like businesses and universities	☐	17
I don't know	☐	9

5.0.6 *C/24 The main job of a computer programmer is to:

operate a computer	☐	42
prepare instructions for a computer	☒	21
schedule jobs for a computer	☐	12
design computers	☐	9
I don't know	☐	16

8

British Columbia Mathematics Assessment 1981

INSTRUCTIONS

HOW TO MARK YOUR ANSWERS

Put an X beside your answer.

For example: Do you live in Canada?

Yes X

No . . . . ___

NOTE: ALL RESULTS ARE REPORTED IN PERCENTS ROUNDED TO THE NEAREST WHOLE NUMBER. SOME SCALES DO NOT TOTAL TO 100 DUE TO "NO RESPONSE" AND/OR ROUNDING ERROR

BACKGROUND INFORMATION

1. Please write your school code number in the boxes on the front cover.

2. What is your date of birth?

Year:

1964 or earlier	1	1
1965	5	2
1966	33	3
1967	58	4
1968	2	5
1969	0	6
1970 or later	0	7

Month:

January	___	01
February	___	02
March	___	03
April	___	04
May	___	05
June	___	06
July	___	07
August	___	08
September	___	09
October	___	10
November	___	11
December	___	12

3. Sex:

Male	50	1
Female	49	2

4. Was English the language you first learned to speak?

Yes	87	1
No	13	2

5. Is English the language usually spoken in your home now?

Yes	92	1
No	7	2

6. In Grade 4 were you attending a school

in this school district?	71	1
elsewhere in British Columbia?	17	2
in another province of Canada?	8	3
outside Canada?	5	4

7. Do you use a calculator at home?

Yes	36	1
No	62	2

8. Do you sometimes use a calculator to do your homework?

Yes	34	1
No	64	2

9. Do you sometimes use a calculator in school?

Yes	15	1
No	84	2

APPENDIX G

GRADE 8 DATA

10. Is there a computer in your school?

No	26	1
Yes	49	2
I don't know	24	3

IF YES

1. Check all of your classes in which it was used during this school year.

1. None	27	1
2. Mathematics	17	1
3. Science	6	1
4. Business Ed.	1	1
5. Computer Science	3	1
6. Other	5	1

2. Check the ways in which the computer was used in your class(es).

Teacher demonstration	14	1
I used it myself	11	1

11. Are you now enrolled in a mathematics course?

Yes	91	1
No	5	2

IF YES

1. How long did it take you to do your last mathematics homework assignment?

There have been no homework assignments	7	1
Between 1 and 10 minutes	22	2
Between 11 and 30 minutes	48	3
Between 31 and 60 minutes	11	4
More than one hour	3	5

12. Both answers given for the following four questions are correct. If you were asked each question, which one of the two answers comes to your mind first?

1. How much does a bicycle weigh?

About 15 kilograms	26	1
About 35 pounds	72	2

2. What is the temperature in this room?

About 70 degrees	60	1
About 20 degrees	38	2

3. How far is it from Prince George to Prince Rupert?

About 700 kilometres	30	1
About 450 miles	67	2

4. How much gasoline can the gas tank in a large car hold?

About 20 gallons	74	1
About 90 litres	23	2

MATHEMATICS AND MYSELF

This is a scale to measure how you feel about mathematics. Below you will find some statements about mathematics. Read each statement and then CIRCLE the choice which best describes how you feel about it.

EXAMPLE:

SKATING IS A WASTE OF TIME.

Strongly Disagree — Disagree — Can't Decide — Agree — Strongly Agree

Please be as honest as possible in rating each statement. There is no correct answer.

Statement	Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
1. I REALLY WANT TO DO WELL IN MATHEMATICS.	1	1	5	44	49
2. MY PARENTS REALLY WANT ME TO DO WELL IN MATHEMATICS.	1	1	3	36	60
3. I AM LOOKING FORWARD TO TAKING MORE MATHEMATICS.	5	14	25	42	15
4. I FEEL GOOD WHEN I SOLVE A MATHEMATICS PROBLEM BY MYSELF.	1	5	11	51	32
5. I USUALLY UNDERSTAND WHAT WE ARE TALKING ABOUT IN MATHEMATICS CLASS.	3	12	15	53	16
6. I AM NOT SO GOOD AT MATHEMATICS.	14	34	17	27	8

7. I LIKE TO HELP OTHERS WITH MATHEMATICS PROBLEMS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
4	15	23	48	9

8. IF I HAD MY CHOICE I WOULD NOT LEARN ANY MORE MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
33	40	15	6	5

9. I FEEL CHALLENGED WHEN I AM GIVEN A DIFFICULT MATHEMATICS PROBLEM.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
4	16	20	45	15

10. I REFUSE TO SPEND A LOT OF MY OWN TIME DOING MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
9	36	23	25	7

11. MATHEMATICS IS HARDER FOR ME THAN FOR MOST PERSONS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
16	42	18	18	6

12. I COULD NEVER BE A GOOD MATHEMATICIAN.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
14	35	20	22	9

13. NO MATTER HOW HARD I TRY I STILL DO NOT DO WELL IN MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
21	45	12	16	[illegible]

14. I WILL WORK A LONG TIME IN ORDER TO UNDERSTAND A NEW IDEA IN MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
5	21	23	39	11

15. WORKING WITH NUMBERS MAKES ME HAPPY.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
7	30	35	23	4

16. IT SCARES ME TO HAVE TO TAKE MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
22	57	12	8	2

17. I USUALLY FEEL CALM WHEN DOING MATHEMATICS PROBLEMS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
[illegible]	17	18	50	11

18. I THINK MATHEMATICS IS FUN.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
13	21	27	30	9

19. WHEN I CANNOT FIGURE OUT A PROBLEM, I FEEL AS THOUGH I AM LOST IN A MAZE AND CANNOT FIND MY WAY OUT.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
6	21	16	39	18

SECOND ASSESSMENT OF MATHEMATICS

GRADE 8 1981

Organization of Test Items

Objective		Test Items*	Page No.
	DOMAIN 1: NUMBER AND OPERATIONS		
1.1	Whole Numbers	A: 1,3,18,31,32,36 B: 1,3,6,24,36,40 C: 1,23,25,32,43,46	3-7
1.2	Fractions and Decimals	A: 5,7,11,12,22,30 B: 13,14,17,23,31,32 C: 2,7,20,21,26,36	8-13
1.3	Ratio, Proportion and Percent	A: 20,23,35,43 B: 12,26,30,43 C: 13,18,19,27	14-16
	DOMAIN 2: GEOMETRY		
2.1	Geometric Figures	A: 4,21 B: 28,34 C: 30,42	17-19
2.2	Geometric Relationships	A: 27,28,41,42 B: 7,37,41,42 C: 10,28,39,45	20-26
2.3	Logical Reasoning *(non-curricular objective)*	A: 29,38 B: 10,33 C: 9,12	27-29
	DOMAIN 3: MEASUREMENT		
3.1	Metric Units	A: 15,17,25 B: 2,15,44 C: 4,17,33	30-32
3.2	Perimeter, Area and Volume	A: 10,16,34,40 B: 16,18,25,27 C: 3,8,34,38	33-37
	DOMAIN 4: ALGEBRAIC TOPICS		
4.1	Expressions, Equations and Inequalities	A: 2,6,8,13,26,44 B: 8,20,21,22,29,35 C: 6,24,29,35,41,44	38-43
4.2	Graphs	A: 37,39 B: 9,19 C: 14,31	44-48
4.3	Probability *(non-curricular objective)*	A: 24,45 B: 11,38 C: 16,22	49-51

A-2

SECOND ASSESSMENT OF MATHEMATICS

GRADE 8 1981

Organization of Test Items (cont'd)

Objective		Test Items*	Page No.
4.4	Statistics *(non-curricular objective)*	A: 9,33,46 B: 5,39,46 C: 5,15,40	52-57
5.0	DOMAIN 5: COMPUTER LITERACY *(non-curricular objective)*	A: 14,19 B: 4,45 C: 11,37	58-60

*A = Test Booklet A
B = Test Booklet B
C = Test Booklet C

DOMAIN 1: NUMBER AND OPERATIONS

OBJECTIVE 1.1: WHOLE NUMBERS

*Note. Items with the symbol * are not part of the Curriculum*

A-3

1.1.1 A/1. Subtract. 5421 − 1927 =

		p-value
4506		3
4504		3
4308		1
3494	X	92
I don't know		1

1.1.2 A/3. Divide. 45 $\sqrt{1232}$

25 remainder 7		8
27 remainder 17	X	72
29 remainder 27		8
207 remainder 17		3
I don't know		9

1.1.3 A/18. Twenty-nine million, fifty-four thousand, three hundred is the same as

29 054 300	X	74
2 900 543 000		1
29 540 300		20
2 900 054 300		4
I don't know		1

1.1.4 A/31. British Columbia became a province of Canada in 1871. Alberta became a province in 1905. How many years after British Columbia did Alberta become a province?

24		4
134		5
74		3
34	X	86
I don't know		2

DOMAIN 1. NUMBER AND OPERATIONS

OBJECTIVE 1.1: WHOLE NUMBERS

A-4

1.1.5 A/32. Paul earned $12 272 in twenty-six weeks. What was his weekly income?

		p-value
$482		8
$472	X	51
$468		14
$293		12
I don't know		15

1.1.6 A/36. As of June 1, 1976, the population of Canada was 22 589 416. Round off 22 589 416 to the nearest ten thousand.

22 580 000		8
23 000 000		9
22 600 000		14
22 590 000	X	65
I don't know		3

1.1.7 B/1 What digit is in the thousands place in the number 23 486?

2		2
3	X	83
4		11
8		3
I don't know		1

1.1.8 B/3 Divide 9315 ÷ 23 =

405 remainder 0	X	72
45 remainder 0		12
450 remainder 3		5
315 remainder 3		4
I don't know		6

1.1.9 B/6. Simplify. $\frac{0}{6}$ =

0	X	42
Infinity		2
6		14
Cannot be done		36
I don't know		6

A-5

DOMAIN 1: NUMBER AND OPERATIONS

OBJECTIVE 1.1: WHOLE NUMBERS

1.1.10 8/24. The chart shows how long it took Ted to deliver papers last week. He worked a total of 320 minutes during the week. How long did it take him to deliver papers on Wednesday?

Day	Mon	Tues	Wed	Thurs	Fri	Sat
Minutes	50	60	?	60	55	45

p-value

- 54 . . . . ___ 4
- 50 . . . . X 80
- 55 . . . ___ 4
- 60 . . . . . . ___ 7
- I don't know . . . . . ___ 5

1 1.11 8/36 If *m* and *n* are any two prime numbers, which one of the following statements is always true?

- $m \times n$ is a composite number . X 25
- $m \div n$ is an integer ___ 13
- $m + n$ is an odd number ___ 17
- $m \times n$ is an even number . ___ 16
- I don't know . . . . ___ 29

1 1.12 8/40 Multiply: 403 x 59

- 24 337 . . . . . ___ 6
- 5 642 . . . ___ 3
- 23 777 . . . . . . X 84
- 3 627 . . . . . . ___ 3
- I don't know . . . . ___ 4

A-6

DOMAIN 1: NUMBER AND OPERATIONS

OBJECTIVE 1.1: WHOLE NUMBERS

1.1.13 C/1 Add: 3872 + 265 + 4932 + 1785

p-value

- 1 854 . . . . ___ 3
- 10 854 . . . . . . X 92
- 10 282 414 . . . . . ___ 1
- 8 644 . . . ___ 3
- I don't know . . . ___ 1

1.1.14 C/23. The greatest common factor of 24 and 30 is:

- 2 . . . . ___ 8
- 6 . . . . X 14
- 120 . . . . ___ 11
- 60 . . . . ___ 3
- I don't know . . . . . ___ 3

1 1 15 C/25. Simplify 4^3 =

- 36 ___ 2
- 64 X 76
- 12 ___ 15
- 32 ___ 4
- I don't know ___ 3

1 1 16 C/32 7(100) + 5(100 000) + 2(10 000) + 8 =

- 207 508 . ___ 3
- 502 708 . ___ 10
- 520 078 ___ 9
- 520 708 . X 65
- I don't know . . . . ___ 12

DOMAIN 1: NUMBER AND OPERATIONS

OBJECTIVE 1.1: WHOLE NUMBERS

A-7

1.1.17 C/43 A Board can be cut into 10 cm lengths or it can be cut into 50 cm lengths or it can be cut into 75 cm lengths, without any waste. How long could the board be?

		p-value
1 m		14
2 m		12
3 m	X	36
4 m		15
I don't know		22

1.1.18 C/46 Multiply 809 x 607

491 063	X	76
54 203		11
5 963		5
10 517		2
I don't know		4

DOMAIN 1: NUMBER AND OPERATIONS

OBJECTIVE 1.2 FRACTIONS AND DECIMALS

A-8

1.2.1 A/5 One fourth of a cake is shared equally among 3 children. What portion of the whole cake did each of the children receive?

		p-value
$\frac{1}{7}$		7
$\frac{3}{4}$		20
$\frac{1}{12}$	X	50
$\frac{1}{3}$		17
I don't know		6

1.2.2 A/7 Sue had a hot dog, french fries and milk. How much did she spend?

MENU			
Hamburger	.85	Milk	.20
Hot Dog	.70	Soft Drink	.15
Grilled Cheese Sandwich	.55	Milk Shake	.45
French Fries	.40	Ice Cream	.40

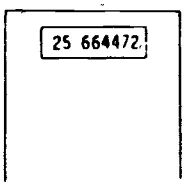
$1.20		1
$1.30	X	95
$1.40		2
$1.50		2
I don't know		•

A-9

DOMAIN 1. NUMBER AND OPERATIONS

OBJECTIVE 1.2. FRACTIONS AND DECIMALS

1 2 3 A/11. The diagram shows a calculator display. Use estimation to decide which of the four exercises would have that answer



		p-value
5.3269 x 4.8179	X	38
3.8245 x 7 93345	___	27
144 971 ÷ 0.56487	___	9
131.427 ÷ 10 6304	___	8
I don't know	___	17

1 2 4 A/12 Subtract 51 2 - 4 35 =

46 95	___	1
46 85	X	6
17 7	___	
7 7	___	7
I don't know	___	4

1 2 5 A/22 Written as a decimal, four and four hundredths is

0 44	___	7
44 00	___	5
4 4	___	12
4 04	X	75
I don't know	___	2

A-10

DOMAIN 1. NUMBER AND OPERATIONS

OBJECTIVE 1.2· FRACTIONS AND DECIMALS

1.2.6 A/30. Which number is largest?

		p-value
$\frac{2}{3}$		35
$\frac{4}{5}$	X	31
$\frac{3}{4}$	___	20
$\frac{5}{8}$	___	11
I don't know	___	2

1.2.7 B/13 Subtract: $12\frac{5}{6} - 3\frac{2}{3} =$

9	___	4
$9\frac{1}{2}$	___	8
$16\frac{1}{2}$	___	3
$9\frac{1}{6}$	X	78
I don't know	___	7

1 2 8 B/14 Seven pies are to be cut into fourths. How many pieces will there be?

7	___	1
28	X	75
36	___	2
I don't know	___	

1 2 9 B/17 There are 13 boys and 15 girls in a group. What fraction of the group is boys?

$\frac{15}{28}$	___	6
$\frac{13}{15}$	___	50
$\frac{15}{13}$	___	5
$\frac{13}{28}$	X	37
I don't know	___	2

A-11

DOMAIN 1 NUMBER AND OPERATIONS

OBJECTIVE 1 2· FRACTIONS AND DECIMALS

1.2.10 B/23. Divide: $12\overline{)036}$

		p-value
3		9
0.003		13
0.3	X	59
0.03		13
I don't know		6

1.2.11 B/31 Divide $\frac{3}{3} \div \frac{15}{8} =$

$1\frac{13}{32}$		6
$2\frac{1}{2}$		15
$\frac{2}{5}$	X	59
$1\frac{1}{2}$		5
I don't know		14

1 2 12 B/32 Patti took [illegible] pictures with her new camera [illegible]ive of the pictures were over-exposed and could not be developed It cost $4 50 to develop the roll What was the cost of each developed picture?

30¢	X	[illegible]
18¢		[illegible]
$22\frac{1}{2}$¢		30
25¢		10
I don't know		[illegible]

1 2.13 C/2 Add $\frac{1}{2} + \frac{1}{3} =$

$\frac{2}{5}$		21
$\frac{1}{5}$		11
$\frac{1}{6}$		6
$\frac{5}{6}$	X	62
I don't know		1

A-12

DOMAIN 1 NUMBER AND OPERATIONS

OBJECTIVE 1 2 FRACTIONS AND DECIMALS

1 2 14 C/7. If 1 kg of oranges costs $0 85, what will be the cost of 4 2 kg?

		p-value
$4.55		5
$4 85		7
$3 98		10
$3 57	X	68
I don't know		10

1 2 15 C/20. Written as a decimal, $\frac{1}{8}$ =

0 12		6
0.8		41
0.125	X	45
0.18		4
I don't know		4

1 2 16 C/21 If a man mowed $\frac{2}{5}$ of his lawn, what part of the lawn does he still have to mow?

$\frac{2}{5}$		
$\frac{1}{5}$		
$\frac{3}{5}$	X	33
0		1
I don't know		5

1 2 17 C/26 Multiply

$$\begin{array}{r} 0\ 84 \\ \times\ 0\ \underline{03} \end{array}$$

25 2		2
2 52		18
0 252		9
0 0252	X	68
I don't know		3

A-13

DOMAIN 1· NUMBER AND OPERATIONS

OBJECTIVE 1.2: FRACTIONS AND DECIMALS

1.2.18 C/36. The decimal point has not yet been placed in the answer to the exercise below:

358.6 X 0 25 = 8965

Which shows the correct placement?

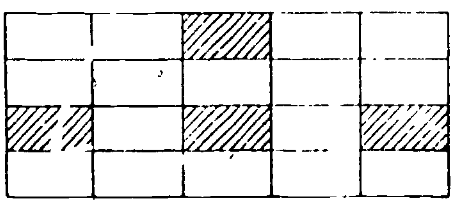
		p-value
0 8965	___	2
896.5	___	4
8.965	___	83
89.65.	X	7
I don't know	___	2

A-14

DOMAIN 1. NUMBER AND OPERATIONS

OBJECTIVE 1.3 RATIO, PROPORTION AND PERCENT

1.3 1 A/20 What percent of the figure is shaded?



		p-value
25%	___	7
4%	___	31
20% . . .	X	54
16%	___	6
I don't know . .	___	2

1.3.2 A/23. If 4 volleyballs cost $96 00, how much will 10 volleyballs cost?

$960.00	___	25
$240.00	X	65
$ 24.00	___	1
$384.00	___	5
I don't know.	___	3

1 3 3 A/35 The distance between two points on a map is 8 5 cm What is the actual distance between the two points if the scale used in the map is 1 cm to 30 km?

305 km		
255 km	X	58
205 km	_	
830 km	___	
I don't know	___	1

1 3 4 A/43 12 is 15% of what number?

80	X	48
180	_	25
800	___	3
1 8	___	7
I don't know . .	___	16

DOMAIN 1: NUMBER AND OPERATIONS

OBJECTIVE 1.3 RATIO, PROPORTION AND PERCENT

1 3 5 B/12. If 37% of the Canadian population is under 20 years of age, what percent of the population is 20 years of age or older?

		p-value
37%		3
63%	X	82
67%		7
137%		2
I don't know		[illegible]

1 3.6 B/26. How does 105% of a number compare in size with the number?

more than twice as large		10
less than half as large		7
slightly smaller		5
slightly larger	X	58
I don't know		21

1 3 7 B/30 A map of B C is to be drawn so that 1 millimetre represents 5 kilometres If the actual distance between Vernon and Penticton is 125 kilometres, how many millimetres apart should these two points be on the map?

125		[illegible]
625		9
120		5
25	X	74
I don't know		7

1 3 8 B/43 A salesman sold $2200 00 worth of merchandise in one month If he earns 8% commission on sales, what is his commission for this month?

$220 00		13
$176 00	X	52
$ 22 00		8
$ 17 60		6
I don't know		19

DOMAIN 1 NUMBER AND OPERATIONS

OBJECTIVE 1 3 RATIO, PROPORTION AND PERCENT

1 3 9 C/13 Written as a percent, $\frac{1}{5}$ =

		p-value
5%		16
0.5%		20
20%	X	61
50%		2
I don't know		2

1.3.10 C/18 A pasture is 48 m long and 30 m wide. How wide should a scale model of the pasture be if the length of the model is 24 cm?

15 cm	X	57
38.4 cm		6
60 cm		9
12 cm		9
I don't know		18

1 3 11 C/19. If pencils cost 36¢ a dozen, how much would 30 pencils cost?

70¢		7
80¢		10
90¢	X	57
99¢		11
I don't know		6

1 3 12 C/27 Written as a decimal, 109% is.

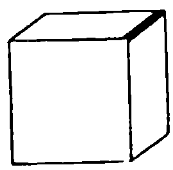
1.09	X	64
1.9		7
0.109		14
109.0		10
I don't know		4

A-17

DOMAIN 2: GEOMETRY

OBJECTIVE 2.1: GEOMETRIC FIGURES

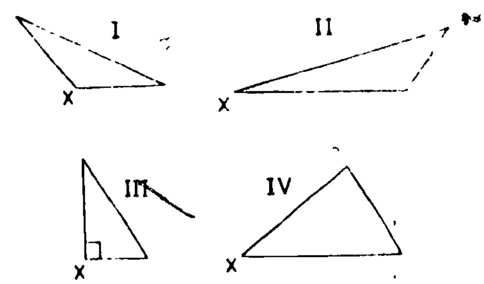
2.1.1 A/4. The heavy line shows one edge of the cube. How many edges does the cube have?



p-value

6 6
5 1
9 19
12 . . . . X 72
I don't know 2

2.1.2 A/21 In which triangle is [illegible] obtuse angle?



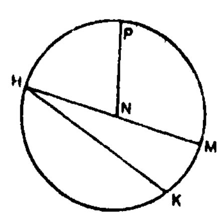
I . . . X 48
II . . . . [illegible]
III . . . [illegible]
IV . . . 8
I don't know . . . 17

A-1[illegible]

DOMAIN 2: GEOMETRY

OBJECTIVE 2.1 GEOMETRIC FIGURES

2.1.3 B/28 If N is the centre, which segment is a diameter?



p-value

$\overline{HK}$ 4
$\overline{NP}$ 19
$\overline{HP}$ 4
$\overline{HM}$ . . . . X 62
I don't know 10

[illegible] 4 B/30 Which of the following is most like a geometric plane

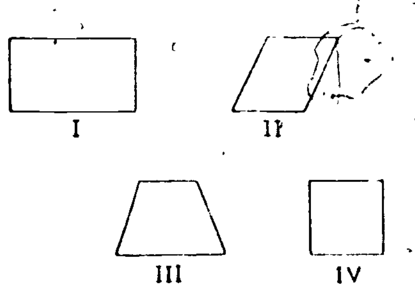
a table top . . . X [illegible]
a water glass . . . 4
an ice cream cone . . . 11
a shoe box . . . [illegible]
I don't know . . . 16

A-19

DOMAIN 2: GEOMETRY

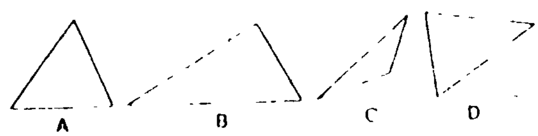
OBJECTIVE 2.1: GEOMETRIC FIGURES

2.1.5 C/30 Which one of these is NOT a parallelogram?



		p-value
I	___	5
II	___	5
III	X	72
IV	___	13
I don't know	___	4

2.1.6 C/42 Which one of the following is most like a right triangle?



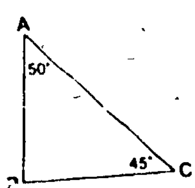
A	___	34
B	X	30
C	___	8
D	___	25
I don't know	___	3

A-20

DOMAIN 2 GEOMETRY

OBJECTIVE 2.2 GEOMETRIC RELATIONSHIPS

2.2.1 A/27 In $\triangle ABC$, $\angle B$ =



		p-value
45°	___	7
50°	___	[illegible]
85°	X	57
90°	___	19
I don't know	___	13

2.2.2 A/28. What is the diameter of a circle with a radius of 4?

8	X	64
6	___	3
4	___	6
2	___	8
I don't know	___	19

2.2.3 A/41 The legs of a right triangle are 6 cm and 8 cm long. How long is the hypotenuse?

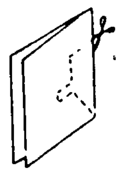
$\sqrt{48}$ cm	___	[illegible]
7 cm	___	[illegible]
100 cm	___	[illegible]
10 cm	X	[illegible]
I don't know	___	[illegible]

A 21

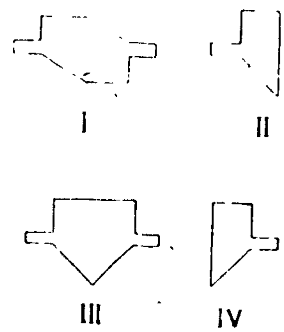
DOMAIN 2 GEOMETRY

OBJECTIVE 2 2: GEOMETRIC RELATIONSHIPS

2.2.4 A/42.



What will the figure above look like when it's cut out and unfolded?

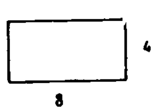


		p-value
I		2
II		5
III	X	90
IV		2
I don't know		1

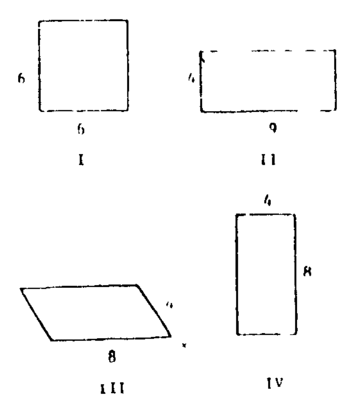
DOMAIN 2: GEOMETRIC FIGURES

OBJECTIVE 2.2· GEOMETRIC RELATIONSHIPS

2.2.5 B/7.



Which one of the following figures is congruent to the figure above?



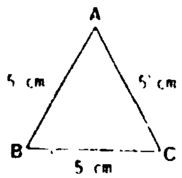
		p-value
I		2
II		11
III		16
IV	X	70
I don't know		2

A 23

DOMAIN 2 GEOMETRIC FIGURES

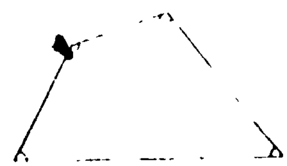
OBJECTIVE 2 2 GEOMETRIC RELATIONSHIPS

2 2 6 B/37 In $\triangle ABC$, $\angle A$



		p-value
90°		10
60°	X	[illegible]
45°		[illegible]
5°		10
I don't know		15

2 2 7 B/41 What is the sum of the angles of the figure below

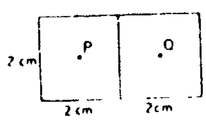


180°	
360°	[illegible]
540°	
Not enough information given	60
I don't know	

DOMAIN 2 GEOMETRY

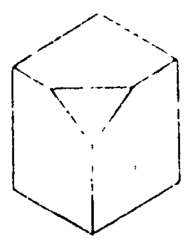
OBJECTIVE 2 2 GEOMETRIC RELATIONSHIPS

2 2 8 B/42 P and Q are the centres of the 2 squares shown What is the distance in centimetres from P to Q?

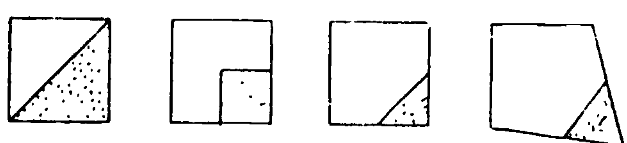


		p-value
1		4
2	X	63
4		15
$\sqrt{2^2 + 2^2}$		9
I don't know		9

2 2 9 C/10



The figure above shows a cube with one corner cut off and shaded Which one of the following drawings show how the cube would look when viewed directly from above?



I II III IV

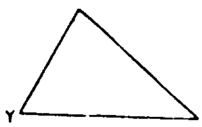
I		2
II		3
III	X	81
IV		13
I don't know		1

A-25

DOMAIN 2: GEOMETRY

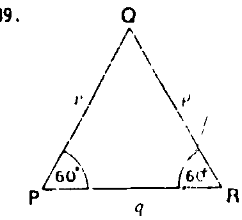
OBJECTIVE 2.2: GEOMETRIC RELATIONSHIPS

2.2.10 C/28. Estimate the number of degrees in angle Y of this triangle.



		p-value
60^0 . . .	X	72
90^0	___	6
30^0 . . .	___	11
120^0 . . .	___	6
I don't know	___	6

2.2.11 C/39.



In ∠PQR, r =

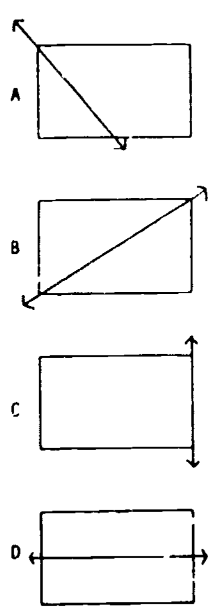
60	___	7
p	X	25
$q + p$	___	17
$r - p$	___	3
I don't know	___	28

A-26

DOMAIN 2: GEOMETRY

OBJECTIVE 2.2. GEOMETRIC RELATIONSHIPS

2.2.12 C/45



Which figure shows a line of symmetry?

		p-value
A	___	6
B	___	27
C	___	11
D	X	36
I don't know	___	20

DOMAIN 2· GEOMETRY

A 27

OBJECTIVE 2 3 LOGICAL REASONING *(non-curricular objective)*

2.3 1* A/29 A LARGE BAG CONTAINS ONLY OBJECTS WHICH ARE LARGE, RED AND ROUND

Which one of the following objects could not be in the bag?

		p-value
a large blue ball	X	77
a large ball		2
a large red ball		9
a red ball		5
I don't know		2

2 3.2* A/38 ALL ROBINS EAT WORMS

Which of the following statements is true given the statement above?

A bird that does not eat a worm is not a robin	X	38
All worms are eaten by robins		36
A bird that is not a robin does not eat worms		0
All worms eat robins		7
I don't know		7

DOMAIN 2 GEOMETRY

A-28

OBJECTIVE 2 3 LOGICAL REASONING

2 3 3* B/30 JOHN HAS MORE MONEY THAN SARA AND SARA HAS MORE MONEY THAN DEBBY

Given these statements, which one of the following statements is true?

John and Debby have the same amount of money		
Debby has more money than John		
John has more money than Debby	X	59
Sara has less money than Debby		
I don't know		

2 3 4 *B/33. Two team captains take turns choosing players for their teams Ellen is always chosen first Chris is always chosen second If Ellen and Chris are never captains, how often do they play on the same team?

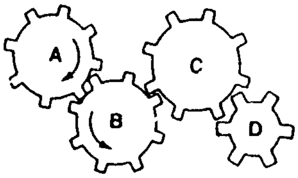
always		0
frequently		0
very rarely		8
never	X	70
I don't know		3

A-29

DOMAIN 2: GEOMETRY

OBJECTIVE 2.3· LOGICAL REASONING

2 3 5 *C/9. Gear A is rotating clockwise Gear B is rotating counterclockwise Which way is 'ear D rotating?



		p-value
clockwise	___	12
counterclockwise	X	79
cannot tell .	___	4
does not rotate	___	3
I don't know	___	1

2 3.6 *C/12. NO STUDENT WHO GRADUATED FROM CENTRAL HIGH SCHOOL IS UNEMPLOYED.

Gerry is unemployed, so we may conclude that,

Gerry did not graduate from Central High School.	X	62
Gerry went to Southside High School.	___	2
Gerry did not go to school	___	6
Gerry did not go to Central High School	___	23
I don't know	___	7

A-30

DOMAIN 3· MEASUREMENT

OBJECTIVE 3 1 METRIC UNITS

3 1.1 A/15. The temperature on a sunny summer day would most likely be

		p-value
5^0 Celsius	___	3
25^0 Celsius . . .	X	53
55^0 Celsius .	___	19
85^0 Celsius . .	___	21
I don't know . . .	___	4

3.1 2 A/17 250 g is how many kilograms?

25	___	24
250	___	3
0.25	X	34
2 5	___	23
I don't know	___	16

3 1 3 A/25. The thickness of a dime is about

1 cm . .	___	6
1 dm	___	7
1 m	___	7
1 mm	X	78
I don't know	___	2

3 1 4 B/2. A metre is about:

the height of a dining room table .	X	85
the height of a grown man	___	4
the height of a skyscraper. . .	___	1
the height of a mouse	___	5
I don't know	___	5

A-31

DOMAIN 3 MEASUREMENT

OBJECTIVE 3.1: METRIC UNITS

3 1.5 B/15. 5 metres is the same length as

		p-value
50 centimetres	___	8
500 centimetres	X	79
50 millimetres	___	3
500 millimetres	___	4
I don't know	___	7

3 1 6 B/44. What is the combined mass of three objects having masses of 600 g, 1.02 kg and 32 g?

1 652 kg	X	25
2 04 kg	___	7
834 g	___	10
733.02 g	___	26
I don't know	___	33

3 1.7 C/4. How many metres are in 0 65 km?

65	___	29
650	X	34
6 5	___	15
0 65	___	5
I don't know	___	16

3 1.8 C/17 A ten-year-old boy is likely to weigh:

35 grams	___	5
75 grams	___	9
35 kilograms	X	56
75 kilograms	___	20
I don't know	___	10

A-32

DOMAIN 3. MEASUREMENT

OBJECTIVE 3.1. METRIC UNITS

3 1 9 C/33. Which one of the following statements is true?

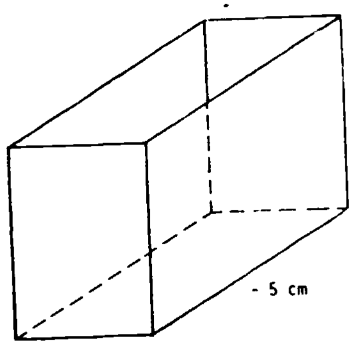
		p-value
100° C is the boiling point of water	X	65
212° C is the boiling point of water	___	9
32° C is the freezing point of water	___	8
10° C is the freezing point of water	___	8
I don't know	___	9

A-33

DOMAIN 3: MEASUREMENT

OBJECTIVE 3.2. PERIMETER, AREA AND VOLUME

3 2.1 A/10 What is the volume of a box that is $\frac{1}{2}$ as long, $\frac{1}{2}$ as wide, and $\frac{1}{2}$ as high as the one given below?



		p-value
60 cm³		20
30 cm³		17
15 cm³		10
7.5 cm³	X	29
I don't know		24

3 2 2 A/16 Mr Jones put a fence around his rectangular garden The garden is 10 m long and 6 m wide How many metres of fencing did he use?

16 m		16
30 m		[illegible]
32 m	X	4[illegible]
60 m		34
I don't know		2

3 2 3 A/34 The area of a dollar bill would be about

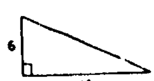
1 m²		[illegible]
10 cm²		50
50 mm²		19
100 cm²	X	13
I don't know		1[illegible]

A-34

DOMAIN 3 MEASUREMENT

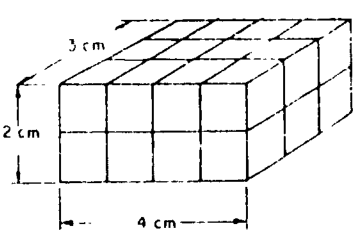
OBJECTIVE 3.2: PERIMETER, AREA AND VOLUME

3 2 4 A/40. Find the area of this right triangle



		p-value
42	X	27
20		20
84		36
21		4
I don't know		14

3 2 5 B/16 What is the volume of this rectangular solid?

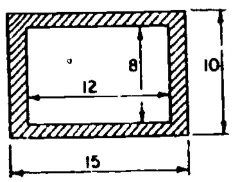


12 cm³		4
26 cm³		4
9 cm³		15
24 cm³	X	69
I don't know		7

DOMAIN 3: MEASUREMENT

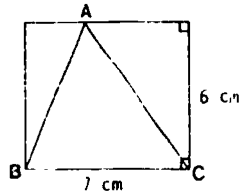
OBJECTIVE 3.2: PERIMETER, AREA AND VOLUME

3.2 6 B/18. What is the area of the shaded portion of this figure?



		p-value
54 . . .	X	33
96 . . .	___	21
120 .	___	7
60 . .	___	10
I don't know . .	___	30

3.2.7 B/25 The area of triangle ABC is



42 cm^2	___	37
49 cm^2 .	___	4
13 cm^2 .	___	11
21 cm^2 . . .	X	28
I don't know	___	19

3.2 8 B/27 What is the approximate length of one side of a square if its area is 200 m^2?

20 m . . .	___	11
100 m . .	___	27
50 m . . .	___	41
14 m	X	9
I don't know . .	___	12

DOMAIN 3 MEASUREMENT

OBJECTIVE 3.2 PERIMETER, AREA AND VOLUME

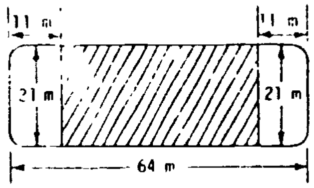
3 2.9 C/3 A rectangular pool of dimensions 4 X 5 X 6 has the same volume as another pool of dimensions 2 X 12 X h What is the value of h?

		p-value
3	___	6
4	___	4
5	X	66
6	___	7
I don't know	___	16

3 2 10 C/8 When the dimensions of a square are doubled, its area becomes how many times as large?

2 times	___	64
4 times .	X	22
6 times .	___	3
8 times	___	8
I don't know	___	3

3 2 11 C/34 What is the area of the shaded portion of this hockey rink?



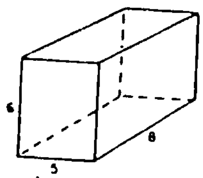
1344 m^2		7
231 m^2	___	9
160 m^2 .	___	18
882 m^2	X	35
I don't know	_	31

A-37

DOMAIN 3: MEASUREMENT

OBJECTIVE 3.2 PERIMETER, AREA AND VOLUME

3.2 12 C/38 Find the volume of this box



		p-value
30		2
40		8
240	X	68
19		12
I don't know		10

A-38

DOMAIN 4 ALGEBRAIC TOPICS

OBJECTIVE 4 1 EXPRESSIONS, EQUATIONS AND INEQUALITIES

4 1 1 A/2. The solution of

$2n + 8 = 20$ is

		p-value
12		11
14		2
6	X	69
10		10
I don't know		8

4 1 2 A/6. Carol earned D dollars during the week. She spent C dollars for clothes and F dollars for food One expression that shows the number of dollars she had left is:

D - C - F	X	77
C + F + D		1
C + F - D		4
D - C + F		14
I don't know		4

4 1 3 A/8 If n is an odd number then the next odd number is:

$n + 1$		1
$n + 2$	X	41
$n + 3$		10
$2n - 1$		7
I don't know		13

4 1 4 A/13 If $y = 15 - x$,

what happens to y as x increases?

y decreases	X	54
y increases		17
y remains the same		11
cannot tell what happens to y		9
I don't know		8

DOMAIN 4 ALGEBRAIC TOPICS

OBJECTIVE 4.1 EXPRESSIONS, EQUATIONS AND INEQUALITIES

4 1 5 A/26 If $3n = 1$, then $n =$

	p-value
1	___ 7
-2	___ 30
$\frac{1}{3}$	X 46
2	___ 4
I don't know	___ 11

4 1 6 A/44 When the input is x the output is

Input	Output
3	7
4	9
5	11
6	13
7	15
8	17
x	___

19	___ 42
$2x - 1$	___ 4
$2x + 1$	X 26
x	___ 12
I don't know	___ 16

4 1 7 B/8 If n is a whole number, then $2n + 1$ is

always even	___ [illegible]
always odd	X 40
sometimes even and sometimes odd	___ 32
never equal to 1	___ 12
I don't know	___ 9

4 1 8 B/20 What values of n make the sentence $(n + 5) - 5 = n$ TRUE?

0 only	___ 26
0 and 5 only	___ 12
all values of n	X 42
no value of n	___ 4
I don't know	___ 16

DOMAIN 4. ALGEBRAIC TOPICS

OBJECTIVE 4 1 EXPRESSIONS, EQUATIONS AND INEQUALITIES

4 1 9 B/21 If x and y are odd numbers, what is true about $x + y$?

	p-value
It is odd	___ 11
It is even	X 56
It may be either even or odd depending on what x and y are	___ 26
You cannot tell at all	___ 4
I don't know	___ 3

4 1 11 B/29 Which one of the following expressions represents twice a number less 5?

$x + 10$	___ 4
$2x - 10$	___ 12
$2x - 5$	X 58
$2x + 5$	___ 6
I don't know	___ 20

4 ~~1.10~~ B/22 Solve $3x - 3 = 12$

$x = 7$	___ 2
$x = 4$	___ 6
$x = 3$	___ 9
$x = 5$	X 72
I don't know	___ 11

A-41

DOMAIN 4 ALGEBRAIC TOPICS

OBJECTIVE 4.1 EXPRESSIONS, EQUATIONS AND INEQUALITIES

4 1 12 B/35 If $n = 5$, then $2n + 4 =$

		p-value
14	X	77
18		3
20		4
11		7
I don't know		9

4 1.13 C/6 Tom has y marbles and Mary has x marbles. Mary has more marbles than Tom Which sentence shows this relation?

$x = y$		1
$x < y$		11
$x > y$	X	84
$x > 2y$		1
I don't know		2

4 1 14 C/24 Which of the following represents the sentence

"If 9 is added to 4 times a number the result is 29"?

$4x - 29 + 9$		
$4(x + 9) = 29$		11
$9x + 4 - 29$		12
$4x + 9 = 29$	X	60
I don't know		11

4 1 15 C/29 One number is 3 times as large as a second number The sum of the two numbers is 72 What are the two numbers?

24 and 8		10
18 and 6		7
12 and 36		9
18 and 54	X	59
I don't know		14

DOMAIN 4 ALGEBRAIC TOPICS

A-42

OBJECTIVE 4.1 EXPRESSIONS, EQUATIONS AND INEQUALITIES

4 1 16 C/35 The following formula has been used to determine the average mass for boys between the ages of 1 and 7

$$M = 9 + 2A$$

where M is the average mass in kilograms and A is the boy's age in years

According to this formula, for each year older a boy gets, how much more should he weigh?

		p-value
2 kg	X	30
9 kg		28
11 kg		18
44 kg		3
I don't know		21

DOMAIN 4 ALGEBRAIC TOPICS

OBJECTIVE 4 1 EXPRESSIONS, EQUATIONS AND INEQUALITIES

4 1 17 C/41. For $m = 2$ and $n = 3$, the value of

$5(3m + 4n)$ is

		p-value
35	___	12
90	X	54
85	___	8
17	___	6
I don't know	___	19

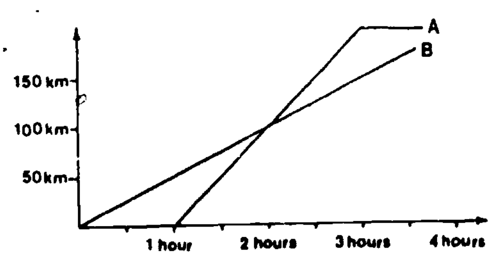
4.1.16 C/44. Which one of the following describes the solution set of $x + 3 > 6$?

all values of x greater than 7	___	22
all values of x greater than 3	X	54
all values of x greater than -2	___	6
all values of x greater than -3	___	4
I don't know	___	15

DOMAIN 4 ALGEBRAIC TOPICS

OBJECTIVE 4 2 GRAPHS

4 2 1 A/37 This is a graph of distance and time for two cars, A and B How many hours after they started the trip did car A pass car B?



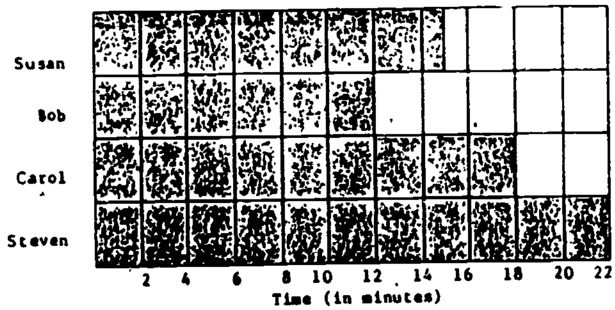
		p-value
after 1 hour	___	14
after 2 hours	X	50
after 3 hours	___	25
after 4 hours	___	6
I don't know	___	5

A-45

DOMAIN 4: ALGEBRAIC TOPICS

OBJECTIVE 4.2: GRAPHS

4 2 2 A/39. Pat was testing his model plane His friends guessed how long it would stay in the air. The plane stayed u for 17 minutes Who guessed closest to the correct time?



		p-value
Susan	___	16
Carol	X	76
Bob	___	2
Steven	___	4
I don't know	___	1

A-46

DOMAIN 4: ALGEBRAIC TOPICS

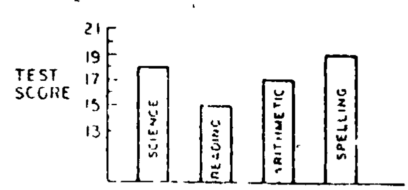
OBJECTIVE 4 2 GRAPHS

4 2 3 B/9. Leslie's test scores were

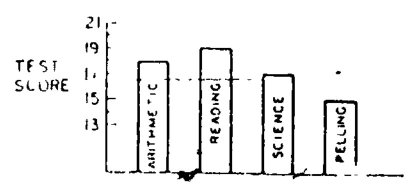
Arithmetic	18
Spelling	15
Science	17
Reading	19

Which graph shows Leslie's results?

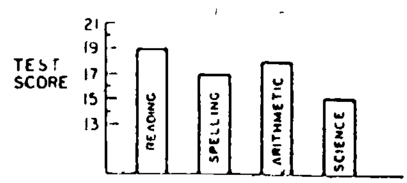
p-value

A)


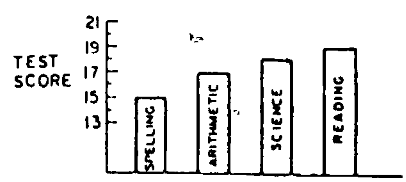
___ 4

B)


X 86

C)


___ 2

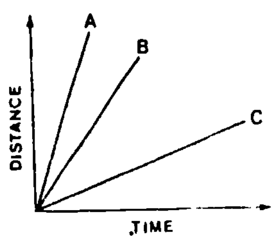
D)


___ 5

E) I don't know ___ 2

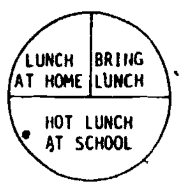
OBJECTIVE 4 2: GRAPHS

4 2 4 B/19 The graph shows the speeds of three cars, A, B and C Which car is travelling fastest·



		p-value
A	X	17
B	___	2
C	___	42
Not enough information given	___	37
I don't know	___	2

4.2.5 C/14. KINDS OF LUNCHES STUDENTS EAT

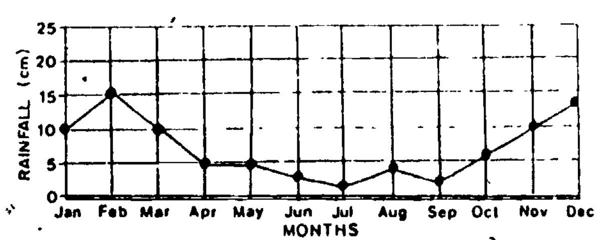


If 400 students eat lunch, about how many go home for lunch?

25	___	10
100	X	69
200	___	11
300	___	2
I don't know	___	7

OBJECTIVE 4.2· GRAPHS

4 2 6 C/31 For how many months was the rainfall more than 5 cm?



		p-value
3	___	5
4	___	5
6	X	85
9	___	2
I don't know	___	2

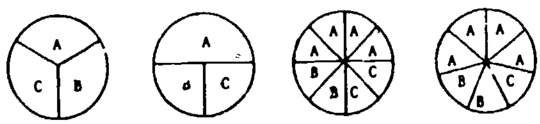
DOMAIN 4: ALGEBRAIC TOPICS A 49

OBJECTIVE 4 3· PROBABILITY *(Non-curricular objective)*

4.3 1 *A/24 Sparky Spencer spun a spinner 100 times and made a record of his results.

Outcome	A	B	C
Number of Times	55	30	15

Which spinner did he most likely use?

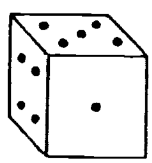


I II III IV

p-value

I	___	12
II	___	9
III	___	18
IV	X	47
I don't know	___	14

4.3.2 *A/45. If on the roll of a die the probability that a five will appear is $\frac{1}{6}$ then the probability that a five or a three will appear is



$\frac{2}{6}$	___	20
$\frac{1}{36}$	___	7
$\frac{1}{3}$	X	49
$\frac{1}{12}$	___	14
I don't know	___	10

DOMAIN 4 ALGEBRAIC TOPICS A-50

OBJECTIVE 4 3 PROBABILITY

4.3.3 * B/11 2,3,4,4,5,6,8,8,9,10

For a party game each number shown above was painted on a different Ping-Pong ball, and the balls were thoroughly mixed up in a bowl. If a ball is picked from the bowl by a blindfolded person, what is the probability that the ball will have a 4 on it?

p-value

A)	$\frac{1}{2}$	___	6
B)	$\frac{1}{4}$	___	16
C)	$\frac{1}{5}$	X	41
D)	$\frac{1}{10}$	___	29
E)	I don't know	___	9

4.3.4* B/38. In Canada, of every 1000 babies born 515 are boys. In a certain hospital, the last 27 babies born have been girls. The next baby born in that hospital will:

almost certainly be a girl (over 80% chance)	___	10
almost certainly be a boy (over 80% chance)	___	21
have a slightly greater chance of being a boy than a girl	X	39
have a slightly greater chance of being a girl than a boy	___	17
I don't know	___	12

DOMAIN 4: ALGEBRAIC TOPICS

OBJECTIVE 4.3 PROBABILITY

4.3.5 *C/16 If the probability that it will rain on a given day is 0.36, then the probability that it will not rain is:

		p-value
0.36		11
0.64	X	48
99.64		25
99.36		4
I don't know		12

4.3.6 *C/22. Mike flips 2 dimes. What is the probability that they will both land heads?

$\frac{1}{4}$	X	22
$\frac{1}{3}$		5
$\frac{1}{2}$		60
$\frac{2}{[illegible]}$		4
I don't know		8

DOMAIN 4: ALGEBRAIC TOPICS

OBJECTIVE 4.4 STATISTICS *(non-curricular objective)*

4.4.1* A/9 AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers Per Month						Total
	Jan	Feb	Mar	Apr	May	Jun	
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

How many more passengers used the airports in January than in April?

		p-value
4		72
2900		1
29		3
400	X	22
I don't know		1

A-53

DOMAIN 4: ALGEBRAIC TOPICS

OBJECTIVE 4.4: STATISTICS

4.4.2* A/33. The average age of 4 children is 6 years. If the ages of 3 of the children are 4 years, 8 years and 3 years, what is the age of the fourth child?

		p-value
6 years		15
9 years	X	39
7 years		12
5 years		22
I don't know		13

4.4.3* A/46 In four months, the volleyball team spent the following amounts travelling to games:

1st month - $17.95
2nd month - $22.40
3rd month - $ 8.25
4th month - $15.80

What was the average amount spent on travelling each month?

$10.10		7
$64.40		18
$32.20		6
$16.10	X	64
I don't know		5

A-54

DOMAIN 4: ALGEBRAIC TOPICS

OBJECTIVE 4.4: STATISTICS

4.4.4* B/5. The median test mark was 37 out of 50. Billy scored 30 out of 50. How many children scored higher than Billy?

		p-value
more than half	X	41
less than half		35
exactly half		4
none		2
I don't know		18

4.4.5* B/39. A television commercial states that 90% of the people who expressed a choice thought that Brand A was better or no different than Brand X. What percent of these people could have thought that Brand X was better or no different than Brand A?

less than 10%		51
up to 100%	X	6
at most 90%		13
cannot tell based on the information		23
I don't know		6

A-55

DOMAIN 4 ALGEBRAIC TOPICS

OBJECTIVE 4.4 STATISTICS

4 4 6 * B/46. Which airport was busiest during the first six months?

AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers Per Month						Total
	Jan	Feb	Mar	Apr	May	Jun	
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

		p-value
Bay City	___	7
Camden	___	2
Dover	X	88
Fiske	___	1
I don't know	___	2

DOMAIN 4 ALGEBRAIC TOPICS

A-56

OBJECTIVE 4 4: STATISTICS

4 4.7 * C/5. The chart shows the population of the earth at different times

Year	1650	1700	1750	1800	1850	1900	1950
Population In Billions	0 60	0 62	0 80	0.95	1 20	1 70	2 55

Which 50 year period showed the largest gain in population?

		p-value
1700 - 1750	___	2
1800 - 1850	___	2
1850 - 1900	___	5
1900 - 1950	X	88
I don't know	___	3

4.4 8 * C/15. Which statistic tells you which event happened the most frequently?

mode	X	15
mean	___	8
median	___	17
range	___	13
I don't know	___	48

DOMAIN 4: ALGEBRAIC TOPICS

A-57

OBJECTIVE 4.4 STATISTICS

4.4.9* C/40

AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers Per Month						Total
	Jan	Feb	Mar	Apr	May	Jun	
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

How many passengers used the Fiske Airport in June?

		p-value
26	___	12
28	___	11
700	X	31
7	___	44
I don't know	___	1

DOMAIN 5. COMPUTER LITERACY

A-58

OBJECTIVE 5.0. *(Non-curricular objective*

5.0.1 *A/14 For which of the following would people not use a computer:

		p-value
to find the sum of a column of numbers . . .	___	6
to keep track of school records	___	4
to decide the winner of a football game	X	55
to put a list of names in alphabetical order . . .	___	29
I don't know	___	3

5.0.2 *A/19. Most computers are.

available to people for all sorts of applications	X	61
so large they require special rooms	___	2
very complicated machines to operate	___	17
so expensive that only very large institutions can own them	___	12
I don't know	___	8

DOMAIN 5. COMPUTER LITERACY

OBJECTIVE 5.0 A-59

5.0.3 * B/4 A computer program is a: *p-value*

course on computers . . . . ____ 44

piece of computer hardware . . . . ____ 2

computer-generated presentation . . . . . ____ 12

set of instructions to control the computer . . . X 32

I don't know . . . . ____ 10

5.0.4 *B/45. Computers are used:

only by very smart people . . . . ____ 2

only by scientists . . . . ____ 1

by many different kinds of people . . . . X 88

only by big institutions like businesses
and universities . . . . ____ 7

I don't know . . . . ____ 3

DOMAIN 5 COMPUTER LITERACY

OBJECTIVE 5 0 A-60

5 0.5* C/11. Computers are used by· *p-value*

some libraries . . . . ____ *

many businesses . . . . ____ 13

the government . . . . ____ 4

all of the above . . . . X 81

I don't know . . . . ____ 2

5.0.6* C/37. In order to solve a problem, a computer:

must use punched cards . . . . ____ 32

must have a set of instructions
written by people . . . . X 46

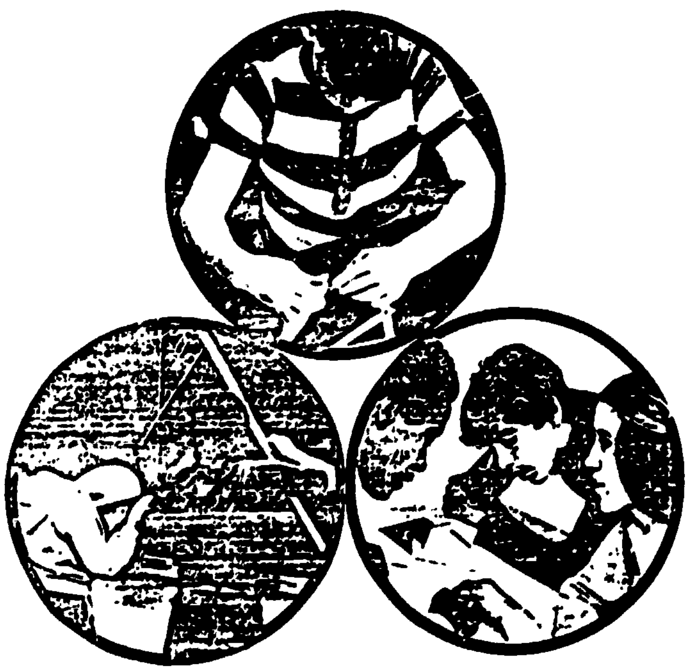
must have solved a similar problem
before . . . . ____ 7

must have blinking lights . . . . ____ 2

I don't know . . . . ____ 13

10

British Columbia Mathematics Assessment 1981



GRADE 10

INSTRUCTIONS

HOW TO MARK YOUR ANSWERS

Put an X beside your answer.

For example: Do you live in Canada?

Yes X

No . . . . . . ___

NOTE: ALL RESULTS ARE REPORTED IN PERCENTS ROUNDED TO THE NEAREST WHOLE NUMBER. SOME SCALES DO NOT TOTAL TO 100 DUE TO "NO RESPONSE" AND/OR ROUNDING ERROR.

BACKGROUND INFORMATION

1. Please write your school code number in the boxes on the front cover.

2. What is your date of birth?

Year:
- 1960 or earlier. . 0 1
- 1961 . . . . 0 2
- 1962 . . . . 0 3
- 1963 . . . . 1 4
- 1964 . . . . 4 5
- 1965 . . . . 33 6
- 1966 or later. . 61 7

Month:
- January. . . . . . ___ 01
- February . . . . ___ 02
- March. . . . . . . ___ 03
- April. . . . . . . ___ 04
- May. . . . . ___ 05
- June . . . . ___ 06
- July . . . . ___ 07
- August . . . . . . ___ 08
- September. . . . . ___ 09
- October. . . . . . ___ 10
- November . . . . . ___ 11
- December . . . . . ___ 12

3. Sex:
- Male 50 1
- Female 47 2

4. Was English the language you first learned to speak?
- Yes 87 1
- No 13 2

5. Is English the language usually spoken in your home now?
- Yes 92 1
- No 7 2

6. In Grade 8 were you attending a school
- In this school district? 85 1
- Elsewhere in British Columbia? 8 2
- In another province of Canada? 5 3
- Outside Canada? 2 4

7. Do you use a calculator at home?
- Yes. 54 1
- No 45 2

8. Do you sometimes use a calculator to do your homework?
- Yes. 65 1
- No 34 2

9. Do you sometimes use a calculator in school?
- Yes. 55 1
- No 44 2

10. Is there a computer in your school?
    - No . . . . 26 [1]
    - Yes. . . . . 57 [2]
    - I don't know . . . . . 16 [3]

IF YES

1. Check all of your classes in which it was used during this school year.
   1. None. . . . . . . 23 [1]
   2. Mathematics . . . 20 [1]
   3. Science . . . . . 8 [1]
   4. Business Education 2 [1]
   5. Computer Science. 10 [1]
   6. Other . . . . . . 4 [1]
2. Check the ways in which the computer was used in your class(es).
   - Teacher demonstration 16 [1]
   - I used it myself. . 16 [1]

11. In which grade are you currently enrolled?
    - Grade 9 5 [1]
    - Grade 10 92 [2]
    - Grade 11 2 [3]
    - Grade 12 0 [4]

12. Check all the mathematics courses you have taken or are presently taking.
    1. Mathematics 8 . . . . 86 [1]
    2. Mathematics 9 . . . . 86 [1]
    3. Mathematics 10. . . . 96 [1]
    4. Algebra 11 (or Algebra 11 enriched). 1 [1]
    5. Consumer Mathematics 11 1 [1]
    6. Trades Mathematics 11 0 [1]

CONTINUED ON NEXT COLUMN

12. *(Continued)*
    7. Computer Science 11 . . . 1 [1]
    8. Algebra 12 (or Algebra 12 enriched) 0 [1]
    9. Geometry 12 . . . . 0 [1]
    10. Probability and Statistics 12 . . . . . . 0 [1]
    11. Other . . . . 3 [1]

13. Are you now enrolled in a mathematics course?
    - Yes. . . 82 [1] (*Go to #1 below*)
    - No . . . 16 [2] (*Go to #2 below*)

IF YES

1. How long did it take you to do your last mathematics homework assignment?
   - There have been no homework assignments. . . 9 [1]
   - Between 1 and 10 minutes 16 [2]
   - Between 11 and 30 minutes 40 [3]
   - Between 31 and 60 minutes 14 [4]
   - More than one hour. . . . 4 [5]

IF NO

2. When did you take your last mathematics course?
   - Earlier in this school year. . . . . 7 [1]
   - During the 1979/80 school year . . . . 7 [2]
   - During the 1978/79 school year . . . . 1 [3]
   - Prior to the 1977/78 school year . . . . 1 [4]

14. Both answers given for the following four questions are correct. If you were asked each question, which one of the two answers comes to your mind first?
    1. How much does a bicycle weigh?
       - About 15 kilograms . 18 [1]
       - About 35 pounds . . 81 [2]
    2. What is the temperature in this room?
       - About 70 degrees . . 64 [1]
       - About 20 degrees . . 35 [2]
    3. How far is it from Prince George to Prince Rupert?
       - About 700 kilometres 24 [1]
       - About 450 miles . 74 [2]
    4. How much gasoline can the gas tank in a large car hold?
       - About 20 gallons . . 81 [1]
       - About 90 litres . . 17 [2]

15. Do you have a part-time job?
    - No (*Go to Question 17*). 49 [1]
    - Yes, involving work only on week ends . . . . . . 15 [2]
    - Yes, involving work only on week days . . . . . . 4 [3]
    - Yes, involving work on both week days and week ends . . . . 24 [4]

16. If you have a part-time job, how many hours per week do you spend on it?
    - Less than 5 hours 7 [1]
    - 5-10 hours . . . . 13 [2]
    - 10-20 hours . . . 17 [3]
    - More than 20 hours 6 [4]

17. What do you plan to do after leaving secondary school?
    - Attend a business school . . 3 [01]
    - Attend vocational, art or trade training school . . . 8 [02]
    - Attend a technical institute 5 [03]
    - Attend community college: university transfer program 4 [04]
    - Attend community college: career program. . . . . . . 6 [05]
    - Attend a university . . . . 26 [06]
    - Look for a job. . . . . . . 10 [07]
    - Take a year off and then return to an education program . . . . 7 [08]
    - Take a year off and then look for a job. . . . . . . 1 [09]
    - Other plans . . . . 6 [10]
    - Undecided . . . . 18 [11]

18. Do you plan to enroll in a post-secondary institution after graduation?

No . . . 30 (1)

Yes. . . 65 (2) *(Go to #1 & #2 below)*

IF YES

1. Which of the following do you hope to attend?

Colleges

Camosun College	1	01
Capilano College	1	02
Cariboo College	2	03
Douglas College	2	04
East Kootenay College	0	05
Fraser Valley College	1	06
Malaspina College	1	07
College of New Caledonia	1	08
North Island College	1	09
Northern Lights College	0	10
Northwest College	0	11
Okanagan College	1	12
Selkirk College	1	13
Vancouver Community College	1	14
Other	3	15

Institutions

B.C.I.T.	6	16
Emily Carr Institute of Fine Arts	0	17
Justice Institute of B.C.	0	18
Open Learning Institute	0	19
Pacific Marine Institute	0	20
Pacific Vocational Institute	3	21
Other	1	22

CONTINUED ON NEXT COLUMN

1. *(Continued)*

Universities

David Thompson University Centre	0	23
Simon Fraser University	3	24
University of B.C.	13	25
University of Victoria	5	26
Other	5	27

2. Indicate the one general area in which you intend to study.

Agriculture and Biological Sciences	4	01
Auto Mechanics	3	02
Business Management and Sciences	4	03
Communications	1	04
Community Services	1	05
Data Processing	1	06
Education	3	07
Electrical/Electronic Technologies	3	08
Engineering and Applied Sciences	3	09
Engineering Technologies	1	10
Fine, Applied and Performing Arts	3	11
Health Professions and Occupations	6	12
Heavy Duty Mechanics	2	13
Hospitality Industry	1	14
Humanities	1	15
Mathematics and Physical Sciences	2	16
Primary Industries (e.g. Forestry, Mining)	2	17
Secretarial Arts and Sciences	2	18
Social Sciences	1	19
Other	12	20
I don't know	12	21

MATHEMATICS AND MYSELF

This is a scale to measure how you feel about mathematics. Below you will find some statements about mathematics. Read each statement and then CIRCLE the choice which best describes how you feel about it.

EXAMPLE:

SKATING IS A WASTE OF TIME.

Strongly Disagree   Disagree   Can't Decide   Agree   Strongly Agree

Please be as honest as possible in rating each statement. There is no correct answer.

Statement	Strongly Disagree (1)	Disagree (2)	Can't Decide (3)	Agree (4)	Strongly Agree (5)
1. I REALLY WANT TO DO WELL IN MATHEMATICS.	1	1	6	55	37
2. MY PARENTS REALLY WANT ME TO DO WELL IN MATHEMATICS.	0	1	4	48	46
3. I AM LOOKING FORWARD TO TAKING MORE MATHEMATICS.	6	21	24	39	10
4. I FEEL GOOD WHEN I SOLVE A MATHEMATICS PROBLEM BY MYSELF.	1	4	9	53	33
5. I USUALLY UNDERSTAND WHAT WE ARE TALKING ABOUT IN MATHEMATICS CLASS.	3	13	15	55	13
6. I AM NOT SO GOOD AT MATHEMATICS.	13	40	14	26	8

7. I LIKE TO HELP OTHERS WITH MATHEMATICS PROBLEMS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
4	18	21	50	6

8. IF I HAD MY CHOICE I WOULD NOT LEARN ANY MORE MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
23	41	18	12	5

9. I FEEL CHALLENGED WHEN I AM GIVEN A DIFFICULT MATHEMATICS PROBLEM.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
4	20	18	46	11

10. I REFUSE TO SPEND A LOT OF MY OWN TIME DOING MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
6	34	22	30	8

11. MATHEMATICS IS HARDER FOR ME THAN FOR MOST PERSONS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
14	46	15	20	5

12. I COULD NEVER BE A GOOD MATHEMATICIAN.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
11	36	18	26	9

13. NO MATTER HOW HARD I TRY I STILL DO NOT DO WELL IN MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
19	50	11	16	4

14. I WILL WORK A LONG TIME IN ORDER TO UNDERSTAND A NEW IDEA IN MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
6	28	23	36	5

15. WORKING WITH NUMBERS MAKES ME HAPPY.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
8	34	31	22	3

16. IT SCARES ME TO HAVE TO TAKE MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
19	58	11	10	2

17. I USUALLY FEEL CALM WHEN DOING MATHEMATICS PROBLEMS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
3	20	18	52	7

18. I THINK MATHEMATICS IS FUN.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
12	27	26	27	6

19. WHEN I CANNOT FIGURE OUT A PROBLEM, I FEEL AS THOUGH I AM LOST IN A MAZE AND CANNOT FIND MY WAY OUT.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
5	24	15	38	17

12

British Columbia
Mathematics Assessment 1981

GRADE 12

INSTRUCTIO...

HOW TO MARK YOUR ANSWERS

Put an X beside your answer.

For example: Do you live in Canada?

Yes X

No . . . . . . ___

NOTE: ALL RESULTS ARE REPORTED IN PERCENTS RO'NDED TO THE NEAREST WHOIE NUMB.R. SOME SCALES DO NOT TOTAL TO 100 DUE TO "NO RESPONSE" AND/OR ROUNDING ERROR.

BACKGROUND INFORMATION

1. Please w.ite your school code number in the boxes on the front cover.

2. What is your date of birth?

Year:
- 1960 or earlier. 1 [1]
- 1961 . . . . 4 [2]
- 1962 . . . . 31 [3]
- 1963 . . . . 62 [4]
- 1964 . . . . 2 [5]
- 1965 . . . . 0 [6]
- 1966 or later. . 0 [7]

Month:
- January. . . . . ___ [01]
- February . . . . ___ [02]
- March. . . . . . ___ [03]
- April. . . . . . ___ [04]
- May. . . . . . . ___ [05]
- June . . . . . . ___ [06]
- July . . . . . . ___ [07]
- August . . . . . ___ [08]
- September. . . . ___ [09]
- October. . . . . ___ [10]
- November . . . . ___ [11]
- December . . . . ___ [12]

3. Sex:
- Male. . . . . . . 48 [1]
- Female. . . . . . 49 [2]

4. Was English the language you first learned to speak?
- Yes. . . . . 86 [1]
- No . . . . 14 [2]

5. Is English the language usually spoken in your home now?
- Yes. . . . . 92 [1]
- No . . . . 7 [2]

6. In Grade 8 were you attending a school
- In this school district? 82 [1]
- Elsewhere in British Columbia? . . . . .10 [2]
- In another province of Canada? . . . . .5 [3]
- Outside Canada? . . . . . .3 [4]

7. Do you use a calculator at home?
- Yes. . . . . . .64 [1]
- No . . . . . . .35 [2]

8. Do you sometimes use a calculator to do your homework?
- Yes. . . . . . .76 [1]
- No . . . . . . .13 [2]

9. Do you sometimes use a calculator in school?
- Yes. . . . . . .74 [1]
- No . . . . . . .25 [2]

10. Is there a computer in your school?
    - No 14 1
    - Yes. 67 2
    - I don't know 18 3

IF YES

1. Check all of your classes in which it was used during this school year.
    1. None. 37 1
    2. Mathematics . . . 12 1
    3. Science 7 1
    4. Business Education 9 1
    5. Computer Science. 15 1
    6. Other 7 1
2. Check the ways in which the computer was used in your class(es).
    - Teacher demonstration 15 1
    - I used it myself. . 21 1

11. In which grade are you currently enrolled?
    - Grade 9 1 1
    - Grade 10 0 2
    - Grade 11 1 3
    - Grade 12 98 4

12. Check all the mathematics courses you have taken or are presently taking.
    1. Mathematics 8 . . . . 92 1
    2. Mathematics 9 . . . . 92 1
    3. Mathematics 10. . . . 91 1
    4. Algebra 11 (or Algebra 11 enriched). 63 1
    5. Consumer Mathematics 11 18 1
    6. Trades Mathematics 11 11 1

CONTINUED ON NEXT COLUMN

12. *(Continued)*
    7. Computer Science 11 . . . 9 1
    8. Algebra 12 (or Algebra 12 enriched) 37 1
    9. Geometry 12 . . . . 6 1
    10. Probability and Statistics 12 . . . . . . 3 1
    11. Other 7 1

13. Are you now enrolled in a mathematics course?
    - Yes. . . 38 1 *(Go to #1 below)*
    - No . . . 60 2 *(Go to #2 below)*

IF YES

1. How long did it take you to do your last mathematics homework assignment?
    - e have been no ork assignments. . . . 3 1
    - n 1 and 10 minutes 4
    - een 11 and 30 minutes 1 3
    - een 31 and 60 minutes 10 4
    - More than one hour. . . . 5 5

IF NO

2. When did you take your last mathematics course?
    - Earlier in this school year. 13 1
    - During the 1979/80 school year 36 2
    - During the 1978/79 school year 9 3
    - Prior to the 1977/78 school year 3 4

14. Both answers given for the following four questions are correct. If you were asked each question, which one of the two answers comes to your mind first?
    1. How much does a bicycle weigh?
        - About 15 kilograms . 16 1
        - About 35 pounds . . 82 2
    2. What is the temperature in this room?
        - About 70 degrees . . 58 1
        - About 20 degrees . . 40 2
    3. How far is it from Prince George to Prince Rupert?
        - About 700 kilometres 22 1
        - About 450 miles . . 77 2
    4. How much gasoline can the gas tank in a large car hold?
        - About 20 gallons . . 79 1
        - About 90 litres . . 19 2

15. Do you have a part-time job?
    - No *(Go to Question 17)*. 34 1
    - Yes, involving work only on week ends 19 2
    - Yes, involving work only on week days 5 3
    - Yes, involving work on both week days and week ends 38 4

16. If you have a part-time job, how many hours per week do you spend on it?
    - Less than 5 hours 4 1
    - 5-10 hours 16 2
    - 10-20 hours . . . 28 3
    - More than 20 hours 13 4

17. What do you plan to do after leaving secondary school?
    - Attend a business school . . 8 01
    - Attend vocational, art or trade training school . . . 8 02
    - Attend a technical institute 5 03
    - Attend community college: university transfer program 11 04
    - Attend community college: career program. 8 05
    - Attend a university 17 06
    - Look for a job 12 07
    - Take a year off and then return to an education program 13 08
    - Take a year off and then look for a job. 1 09
    - Other plans 8 10
    - Undecided 8 11

18. Do you plan to enroll in a post-secondary institution after graduation?

No . . . 28 [1]
Yes. . . 69 [2] *(Go to #1 & #2 below)*

IF YES

1. Which of the following do you hope to attend?

Colleges

Camosun College	2	01
Capilano College	1	02
Cariboo College	2	03
Douglas College	4	04
East Kootenay College . . .	0	05
Fraser Valley College . . .	1	06
Malaspina College	2	07
College of New Caledonia. .	1	08
North Island College . . .	1	09
Northern Lights College . .	0	10
Northwest College	0	11
Okanagan College	2	12
Selkirk College	1	13
Vancouver Community College	3	14
Other	4	15

Institutions

B.C.I.T.	6	16
Emily Carr Institute of Fine Arts . . .	0	17
Justice Institute of B.C. .	0	18
Open Learning Institute . .	0	19
Pacific Marine Institute. .	0	20
Pacific Vocational Institute	4	21
Other	1	22

CONTINUED ON NEXT COLUMN

1. *(Continued)*

Universities

David Thompson University Centre. . .	0	23
Simon Fraser University	3	24
University of B.C . .	9	25
University of Victoria	4	26
Other.	2	27

2. Indicate the one general area in which you intend to study.

Agriculture and Biological Sciences. .	3	01
Auto Mechanics	2	02
Business Management and Science	8	03
Communications	1	04
Community Services . .	1	05
Data Processing . . .	2	06
Education.	4	07
Electrical/Electronic Technologies	2	08
Engineering and Applied Sciences	4	09
Engineering Technologies	2	10
Fine, Applied and Performing Arts . . .	5	11
Health Professions and Occupations.	6	12
Heavy Duty Mechanics .	2	13
Hospitality Industry .	1	14
Humanities	1	15
Mathematics and Physical Sciences	2	16
Primary Industries (e.g. Forestry, Mining)	1	17
Secretarial Arts and Sciences	2	18
Social Sciences . . .	2	19
Other	12	20
I don't know	7	21

MATHEMATICS AND MYSELF

This is a scale to measure how you feel about mathematics. Below you will find some statements about mathematics. Read each statement and then CIRCLE the choice which best describes how you feel about it.

EXAMPLE:

SKATING IS A WASTE OF TIME.

Strongly Disagree | Disagree | Can't Decide | Agree | Strongly Agree

Please be as honest as possible in rating each statement. There is no correct answer.

1. I REALLY WANT TO DO WELL IN MATHEMATICS.

Strongly Disagree [1]	Disagree [2]	Can't Decide [3]	Agree [4]	Strongly Agree [5]
2	7	13	54	23

2. MY PARENTS REALLY WANT ME TO DO WELL IN MATHEMATICS.

Strongly Disagree [1]	Disagree [2]	Can't Decide [3]	Agree [4]	Strongly Agree [5]
1	6	10	54	28

3. I AM LOOKING FORWARD TO TAKING MORE MATHEMATICS.

Strongly Disagree [1]	Disagree [2]	Can't Decide [3]	Agree [4]	Strongly Agree [5]
16	35	26	19	5

4. I FEEL GOOD WHEN I SOLVE A MATHEMATICS PROBLEM BY MYSELF.

Strongly Disagree [1]	Disagree [2]	Can't Decide [3]	Agree [4]	Strongly Agree [5]
2	4	7	57	29

5. I USUALLY UNDERSTAND WHAT WE ARE TALKING ABOUT IN MATHEMATICS CLASS.

Strongly Disagree [1]	Disagree [2]	Can't Decide [3]	Agree [4]	Strongly Agree [5]
6	18	15	51	10

6. I AM NOT SO GOOD AT MATHEMATICS.

Strongly Disagree [1]	Disagree [2]	Can't Decide [3]	Agree [4]	Strongly Agree [5]
11	36	14	29	10

7. I LIKE TO HELP OTHERS WITH MATHEMATICS PROBLEMS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
7	24	19	45	6

8. IF I HAD MY CHOICE I WOULD NOT LEARN ANY MORE MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
13	33	22	23	9

9. I FEEL CHALLENGED WHEN I AM GIVEN A DIFFICULT MATHEMATICS PROBLEM.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
6	22	17	[illegible]	10

10. I REFUSE TO SPEND A LOT OF MY OWN TIME DOING MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
5	30	18	36	10

11. MATHEMATICS IS HARDER FOR ME THAN FOR MOST PERSONS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
11	44	17	21	7

12. I COULD NEVER BE A GOOD MATHEMATICIAN.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
8	33	17	29	12

13. NO MATTER HOW HARD I TRY I STILL DO NOT DO WELL IN MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
15	49	12	18	6

14. I WILL WORK A LONG TIME IN ORDER TO UNDERSTAND A NEW IDEA IN MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
7	35	20	33	6

15. WORKING WITH NUMBERS MAKES ME HAPPY.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
9	35	28	24	4

16. IT SCARES ME TO HAVE TO TAKE MATHEMATICS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
14	55	13	14	3

17. I USUALLY FEEL CALM WHEN DOING MATHEMATICS PROBLEMS.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
6	27	20	43	4

18. I THINK MATHEMATICS IS FUN.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
17	30	25	24	4

19. WHEN I CANNOT FIGURE OUT A PROBLEM, I FEEL AS THOUGH I AM LOST IN A MAZE AND CANNOT FIND MY WAY OUT.

Strongly Disagree 1	Disagree 2	Can't Decide 3	Agree 4	Strongly Agree 5
5	24	15	39	17

SECOND ASSESSMENT OF MATHEMATICS

Grades 10 and 12 1981

Organization of Test Items

Objective		Test Items*	Page No.
	DOMAIN 1: NUMBER AND OPERATIONS		
1.1	Number Concepts	A: 6,12,30 B: 10,11,20	2-3
1.2	Computation with Fractions and Decimals	A: 2,8,20,22,33 B: 2,15,19,24,34	4-7
1.3	Ratio, Proportion and Percent	A: 10,24,37 B: 4,9,45	8-9
	DOMAIN 2: GEOMETRY		
2.1	Geometric Figures	A: 26,27,29 B: 16,26,27	10-12
2.2	Geometric Relationships	A: 18,36,42 B: 18,32,43	13-15
2.3	Logical Reasoning *(non-curricular objective)*	A: 7,21,38 B: 13,29,31	16-18
	DOMAIN 3: MEASUREMENT		
3.1	Metric Units	A: 11,13,19 B: 8,12,41	19-20
3.2	Perimeter, Area and Volume	A: 23,32,43 B: 17,21,40	21-23
	DOMAIN 4: ALGEBRAIC TOPICS		
4.1	Expressions, Equations and Inequalities	A: 14,15,25,28,39,41,45 B: 7,23,25,38,39,42,44	24-27
4.2	Graphs	A: 1,34,44 B: 1,14,30	28-30
4.3	Probability *(non-curricular objective)*	A: 4,31,35 B: 6,33,37	31-33
4.4	Statistics *(non-curricular objective)*	A: 3,16,40 B: 5,35,36	34-36
5.0	DOMAIN 5: COMPUTER LITERACY *(non-curricular objective)*	A: 5,9,17 B: 3,22,28	37-39

*A = Test Booklet A
B = Test Booklet B

DOMAIN 1: NUMBER AND OPERATION

A-2

OBJECTIVE 1.1: NUMBER CONCEPTS

*Note: Items with the symbol * are not part of the Curriculum*

1.1.1 A/6. Expressed in scientific notation, the depth of a certain part of the ocean is 3.6×10^2 metres. What is the value of 3.6×10^2?

		p-value gr 10	gr 12
36	___	2	1
3600	___	27	27
1296	___	*	1
360	X	67	66
I don't know	___	*	4

1.1.2 A/12. 31.8 L is a measurement which has been rounded to the nearest tenth. Which of the following is not a possible value for the measurement before it was rounded?

31.76 L	___	6	4
31.80 L	___	10	7
31.749 L	X	47	49
31.849 L	___	25	30
I don't know	___	11	9

1.1.3 A/30. Simplify: $30 - 4(8 - 2) =$

0	___	7	4
20	___	7	7
156	___	13	12
6	X	68	71
I don't know	___	6	6

1.1.4 B/10. Estimate the product: $49.72 \times 8.46 \times 9.98$. (Do not take the time to perform the calculation.)

400	___	5	3
4000	X	44	48
3900	___	24	24
5000	___	24	21
I don't know	___	4	4

DOMAIN 1: NUMBER AND OPERATION

A-3

OBJECTIVE 1.1: NUMBER CONCEPTS

1.1.5 B/11. There are 13 boys and 15 girls in a group. What fraction of the group is boys?

		p-value gr 10	gr 12
$\frac{15}{28}$	___	5	6
$\frac{13}{15}$	___	42	37
$\frac{15}{13}$	___	5	4
$\frac{13}{28}$	X	48	52
I don't know	___	1	1

1.1.6 B/20. The closest estimate for $\sqrt{640}$ would be:

20	___	8	8
30	___	8	6
25	X	43	46
80	___	36	34
I don't know	___	3	6

A-4

DOMAIN 1: NUMBER AND OPERATION

OBJECTIVE 1.2: COMPUTATION WITH FRACTIONS AND DECIMALS

1.2.1 A/2. Written as a decimal, $\frac{3}{8}$ =

		p-value gr 10	p-value gr 12
0.3		4	4
0.24		13	11
0.375	X	77	80
1.666		1	1
I don't know		5	4

1.2.2 A/8. Divide: $\frac{2}{3} \div \frac{5}{7}$

$\frac{10}{21}$		10	11
$\frac{14}{15}$	X	79	77
$\frac{9}{8}$		1	1
$\frac{15}{14}$		6	6
I don't know		4	5

1.2.3 A/20. Good-Taste Caterers used $3\frac{1}{2}$ rolls of aluminum foil wrap at a wedding. At the next wedding, they will need $2\frac{1}{2}$ times as much. How many rolls will be needed?

6 rolls		18	12
7 rolls		17	12
8 rolls		16	17
9 rolls	X	45	56
I don't know		5	3

1.2.4 A/22. Divide $.12\overline{).036}$

3		7	5
0.003		8	9
0.3	X	75	72
0.03		9	11
I don't know		2	3

A-5

DOMAIN 1: NUMBER AND OPERATION

OBJECTIVE 1.2: COMPUTATION WITH FRACTIONS AND DECIMALS

1.2.5 A/33. Tracy and Lisa earned $75 by painting their grandmother's house. Lisa only worked $\frac{2}{3}$ as many hours as Tracy did. How much should Lisa be paid?

		p-value gr 10	p-value gr 12
$50		39	37
$45		7	7
$30	X	33	37
$20		12	11
I don't know		9	8

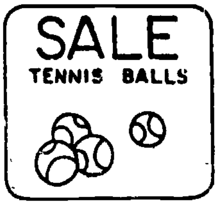
1.2.6 B/2 A recipe for punch calls for $3\frac{3}{4}$ units of pineapple juice for 10 people. How many units of pineapple juice should be used to make the same punch to serve five people?

$1\frac{7}{8}$	X	65	71
$7\frac{1}{2}$		7	5
$2\frac{1}{4}$		9	8
$1\frac{3}{4}$		13	12
I don't know		5	4

DOMAIN 1: NUMBER AND OPERATION

OBJECTIVE 1.2: COMPUTATION WITH FRACTIONS AND DECIMALS

1.2.7 8/15. Tennis balls are on sale at 4 sport shops. You would pay the lowest price per ball if you bought at the store which offers.



		p-value gr 10	p-value gr 12
8 tennis balls for $7.25	___	16	14
1 dozen balls for $11.00	___	19	18
tennis balls for $0.95 each	___	7	5
3 tennis balls for $2.70	X	53	59
I don't know	___	5	3

1.2.8 8/19. Five times as many people visit a zoo on Saturdays as on each of the other days of the week. What fraction of the weekly visitors come to the zoo on Saturdays?

A-6

$\frac{5}{7}$	___	65	62
$\frac{2}{5}$	___	8	7
$\frac{5}{12}$	___	6	7
$\frac{5}{11}$	X	7	12
I don't know	___	15	13

1.2.9 8/24. Wendy bought 3 record albums on sale. The regular price was $7.24 each and the sale price was $1.50 off each record. If she paid 69¢ sales tax on her total purchase, how much money did she spend?

$17.22	___	9	9
$17.91	X	71	75
$21.72	___	10	8
$22.91	___	5	4
I don't know	___	6	4

DOMAIN 1: NUMBER AND OPERATION

OBJECTIVE 1.2: COMPUTATION WITH FRACTIONS AND DECIMALS

A-7

1.2.10 8/34. Which number is largest?

		p-value gr 10	p-value gr 12
$\frac{2}{3}$	___	26	21
$\frac{4}{5}$	X	49	57
$\frac{3}{4}$	___	17	16
$\frac{5}{8}$	___	7	5
I don't know	___	1	1

A-8

DOMAIN 1: NUMBER AND OPERATION

OBJECTIVE 1.3: RATIO, PROPORTION AND PERCENT

1.3.1 A/10. At a party the ratio of boys to girls was 2 to 1. What percent of the people at the party were girls?

		p-value gr 10	p-value gr 12
$\frac{2}{3}$		11	19
50%		26	21
$33\frac{1}{3}$%	X	49	56
200%		7	6
I don't know		7	5

1.3.2 A/24. Written as a decimal, 20% =

0.2	X	76	80
0.02		10	8
2.0		4	2
20.0		9	8
I don't know		1	1

1.3.3 A/37. The lengths of two coils of rope are in the ratio of 7 to 9. Find the length of the longer segment, if the shorter is 9 m long.

$\frac{81}{7}$ m	X	39	45
81 m		17	13
7 m		14	12
9 m		2	1
I don't know		29	29

1.3.4 B/4. A map of a large ranch was drawn to a scale of 2 cm to 50 m. On the map the distance from the house to one of the barns was 13 cm. What was the actual distance between the house and the barn?

650 m		20	17
66 m		7	[illegible]
1300 m		8	6
325 m	X	55	60
I don't know		10	10

A-9

DOMAIN 1: NUMBER AND OPERATION

OBJECTIVE 1.3: RATIO, PROPORTION AND PERCENT

1.3.5 B/9. Written as a percent, $\frac{1}{5}$ =

		p-value gr 10	p-value gr 12
5%		7	6
0.5%		15	16
20%	X	76	77
50%		1	1
I don't know		1	1

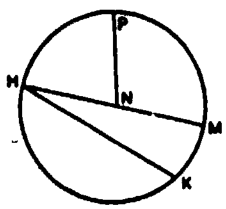
1.3.6 B/45. A salesman receives 20% of the retail value of his sales as a commission. What must his total sales be if he is to earn a commission of $60?

$1200		30	25
$ 80		5	4
$ 300	X	50	58
$ 240		6	7
I don't know		9	7

DOMAIN 2: GEOMETRY

OBJECTIVE 2.1: GEOMETRIC FIGURES

2.1.1 A/26. If N is the centre, which segment is a diameter?



		p-value gr. 10	gr. 12
$\overline{HK}$	___	1	1
$\overline{NP}$	___	12	11
$\overline{HP}$	___	1	2
$\overline{HM}$	X	80	81
I don't know	___	6	5

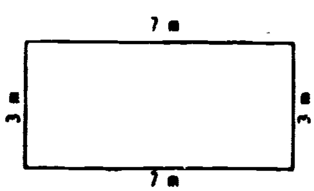
2.1.2 A/27. The perimeter of an isosceles triangle is 21 cm and the length of one of its equal sides is 9 cm. What is the length of the shortest side?

6 cm	___	8	7
1.5 cm	___	3	2
4.5 cm	___	4	4
3 cm	X	71	72
I don't know	___	14	15

DOMAIN 2: GEOMETRY

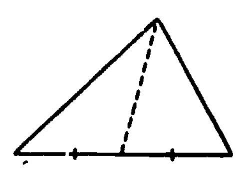
OBJECTIVE 2.1: GEOMETRIC FIGURES

2.1.3 A/29. In the figure below, the lengths of the sides ar m. Which one of the follo ensures that the figure rectangle?



		p-value gr. 10	gr. 12
the opposite sides are congruent	___	56	50
the opposite angles are congruent	___	8	8
the angles are right angles	X	17	24
the opposite sides are parallel	___	33	32
I don't know	___	3	6

2.1.4 D/16. What is the name given to the dashed line in this figure?

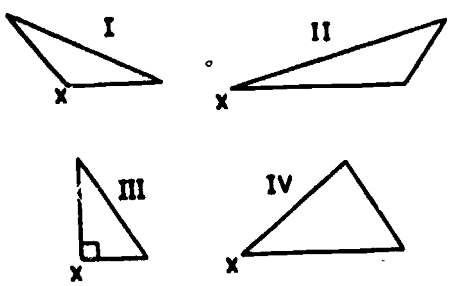


median	X	20	20
altitude	___	18	13
angle bisector	___	39	42
hypotenuse	___	9	12
I don't know	___	14	14

DOMAIN 2: GEOMETRY

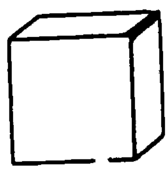
OBJECTIVE 2.1: GEOMETRIC FIGURES

2.1.5 B/28. In which triangle is angle X an obtuse angle?



I	X	<u>54</u>	<u>54</u>
II		13	12
III		9	8
IV		6	5
I don't know		18	20

2.1.6 B/27. The heavy line shows one edge of the cube. How many edges does the cube have?

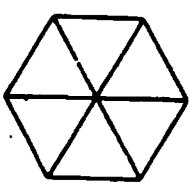


5		1	1
6		5	4
9		7	8
12	X	[illegible]	<u>86</u>
I don't know		2	2

DOMAIN 2: GEOMETRY

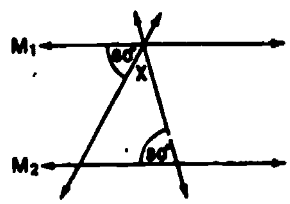
OBJECTIVE 2.2: GEOMETRIC RELATIONSHIPS

2.2.1 A/18. A regular hexagon is formed of 6 equilateral triangles. If the perimeter of each triangle is 9 cm, what is the perimeter of the hexagon?



		p-value gr. 10	gr. 12
12 cm		1	1
18 cm	X	<u>43</u>	<u>43</u>
27 cm		1	2
54 cm		52	51
I don't know		3	3

2.2.2 A/36.



In the diagram M_1 is parallel to M_2.
$\angle X =$

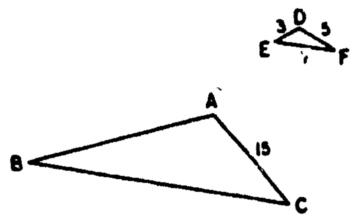
60°		16	13
40°	X	<u>46</u>	<u>53</u>
20°		21	16
80°		5	4
I don't know		13	13

DOMAIN 2: GEOMETRY

OBJECTIVE 2.2: GEOMETRIC RELATIONSHIPS

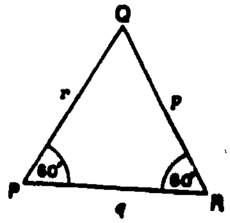
A-14

2.2.3 A/42. Triangle ABC is similar to triangle DFE. Find the length of segment BC.



		p-value gr 10	gr 12
21		39	60
15		2	3
35	X	25	21
$\frac{45}{7}$		2	2
I don't know		12	13

2.2.4 B/18.



In $\triangle PQR$, r =

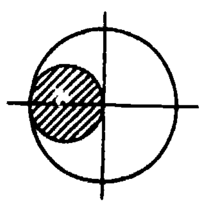
60		22	14
p	X	44	54
$q + p$		12	10
$q - p$		3	2
I don't know		18	20

DOMAIN 2: GEOMETRY

OBJECTIVE 2.2: GEOMETRIC RELATIONSHIPS

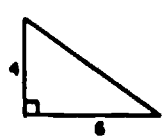
A-15

2.2.5 B/32 What fractional part of the large circle is shaded?



		p-value gr 10	gr 12
$\frac{1}{5}$		10	9
$\frac{1}{4}$	X	72	74
$\frac{1}{3}$		6	8
$\frac{1}{8}$		5	4
I don't know		7	5

2.2.6 B/43. If two sides of a right triangle are 6 cm and 4 cm long, find the length of the hypotenuse.

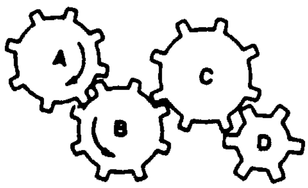


$\sqrt{20}$		7	5
10		23	22
52		8	6
$\sqrt{52}$	X	45	49
I don't know		18	19

DOMAIN 2: GEOMETRY A-16

OBJECTIVE 2.3: LOGICAL REASONING *(non-curricular objective)*

2.3.1* A/7. Gear A is rotating clockwise. Gear B is rotating counter-clockwise. Which way is Gear D rotating?



		p-value gr 10	gr 12
clockwise		11	10
counterclockwise	X	86	88
cannot tell		2	1
Does not rotate		1	1
I don't know		*	1

2.3.2* A/21. JOHN HAS MORE MONEY THAN SARA AND SARA HAS MORE MONEY THAN DEBBY.

Given these statements, which of the following statements is true?

John and Debby have the same amount of money		2	2
Debby has more money than John		2	1
Sara has less money than Debby		1	2
John has more money than Debby	X	93	93
I don't know		1	2

DOMAIN 2: GEOMETRY A-17

OBJECTIVE 2.3: LOGICAL REASONING *(non-curricular objective)*

2.3.3* A/38. ALL ROBINS EAT WORMS.

Which of the following statements is true given the statement above?

		p-value gr 10	gr 12
All worms are eaten by robins		34	27
A bird that does not eat a worm is not a robin	X	47	54
A bird that is not a robin does not eat worms		8	9
All worms eat robins		2	2
I don't know		8	6

2.3.4 *B/13. Two team captains take turns choosing players for their teams. Ellen is always chosen first. Chris is always chosen second. If Ellen and Chris are never captains, how often do they play on the same team?

always		7	6
frequently		6	4
very rarely		4	4
never	X	81	83
I don't know		2	2

DOMAIN 2: GEOMETRY

A-18

OBJECTIVE 2.3: LOGICAL REASONING *(non-curricular objective)*

2.3.5 * B/29 A LARGE BAG CONTAINS ONLY OBJECTS WHICH ARE LARGE, RED AND ROUND.

Which of the following objects could not be in the bag?

		p-value gr 10	gr 12
a large blue ball	X	74	79
a large ball		1	1
a large red ball		4	4
a red ball		3	2
I don't know		2	2

2.3.6 * B/31 NO STUDENT WHO GRADUATED FROM CENTRAL HIGH SCHOOL IS UNEMPLOYED.

Gerry is unemployed, so we may conclude that:

		gr 10	gr 12
Gerry did not graduate from Central High School	X	72	75
Gerry went to Southside High School		1	1
Gerry did not go to school		2	2
Gerry did not go to Central High School		19	16
I don't know		4	3

DOMAIN 3: MEASUREMENT

A-19

OBJECTIVE 3.1: METRIC UNITS

3.1.1 A/11. How many metres are in 0.65 km?

		p-value gr 10	gr 12
65		25	22
650	X	51	53
6.5		11	10
0.65		2	2
I don't know		11	13

3.1.2 A/13. A ten-year-old boy is likely to weigh:

		gr 10	gr 12
35 grams		4	3
75 grams		6	4
35 kilograms	X	65	68
75 kilograms		14	14
I don't know		12	12

3.1.3 A/19. 250 g is how many kilograms?

		gr 10	gr 12
25		16	13
250		1	1
0.25	X	51	56
2.5		21	19
I don't know		10	11

3.1.4 B/8. If the temperature in Vancouver on a given day is 28° C then the season is most likely:

		gr 10	gr 12
fall		4	2
spring		15	6
summer	X	76	90
winter		3	2
I don't know		2	1

A-20

DOMAIN 3: MEASUREMENT

OBJECTIVE 3.1: METRIC UNITS

3.1.5 B/12. 5 metres is the same length as:

		p-value gr 10	p-value gr 12
50 centimetres	___	5	7
500 centimetres	X	87	85
50 millimetres	___	1	1
500 millimetres	___	3	2
I don't know	___	3	5

3.1.6 B/41. How much would 200 g of meat cost if the price of meat is $10/kg?

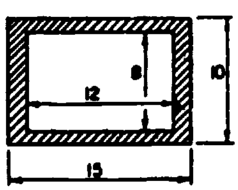
$ 2	X	44	47
$ 5	___	6	6
$20	___	39	32
$10	___	3	3
I don't know	___	9	11

A-21

DOMAIN 3: MEASUREMENT

OBJECTIVE 3.2: PERIMETER, AREA AND VOLUME

3.2.1 A/23. What is the area of the shaded portion of this figure?



		p-value gr 10	p-value gr 12
54	X	56	56
96	___	16	15
120	___	4	5
60	___	7	8
I don't know . . .	___	16	17

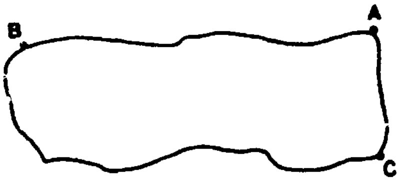
3.2.2 A/32. Find the area of this right triangle:

42	X	47	49
20	___	8	6
84	___	28	27
21	___	4	3
I don't know . . .	___	13	14

DOMAIN 3: MEASUREMENT

OBJECTIVE 3.2: PERIMETER, AREA AND VOLUME

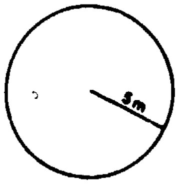
3.2 3 A/43. Towns A, B and C lie on the shore of a lake as shown in the map below. The distance from A to B is 7.8 km and the distance from A to C is 2.4 km. Which of the following is the best estimate for the area of the lake?



		p-value gr 10	gr 12
10 km^2	___	15	13
18 km^2	X	52	55
14 km^2	___	11	9
24 km^2	___	12	11
I don't know	___	9	12

3.2.4 B/17. The best estimate for the area of the circle shown is:

15 m^2	___	15	11
75 m^2	X	34	34
100 m^2	___	6	6
5 m^2	___	32	33
I don't know	___	14	16



DOMAIN 3: MEASUREMENT

OBJECTIVE 3.2: PERIMETER, AREA AND VOLUME

3.2.5 B/21. The perimeter of a square is 12 centimetres. Find the area in square centimetres.

		p-value gr 10	gr 12
48	___	14	12
9	X	36	38
12	___	4	4
144	___	40	39
I don't know	___	6	8

3.2.6 B/40. A small cube measures 2 cm by 2 cm by 2 cm. How many of these can be put into a rectangular box that is 24 cm long by 10 cm wide by 6 cm deep?

60	___	19	15
180	X	54	58
720	___	11	8
1440	___	5	4
I don't know	___	12	15

A-24

DOMAIN 4: ALGEBRAIC TOPICS

OBJECTIVE 4.1: EXPRESSIONS, EQUATIONS AND INEQUALITIES

4.1.1 A/14. $\frac{4}{5}A + B = C$

Solve for A in terms of B and C.

		p-value gr 10	p-value gr 12
$A = \frac{5}{4}C - B$	___	9	8
$A = \frac{5}{4}(C - B)$	X	<u>24</u>	<u>43</u>
$A = \frac{4}{5}C - B$	___	15	10
$A = \frac{4}{5}(C - B)$	___	21	15
I don't know	___	31	23

4.1.2 A/15. Which of the following describes the solution set of $(x - 2)^2 = 9$?

$x = 5$ or $x = -1$	X	<u>21</u>	<u>56</u>
$x = 5$ or $x = -5$	___	13	10
$x = 5$	___	33	26
$x = -1$	___	5	4
I don't know	___	28	23

4.1.3 A/25. When $m = -1$ and $n = 1$, the value of $\frac{m^{20}}{n}$ is:

-1	___	13	11
1	X	<u>40</u>	<u>49</u>
-20	___	28	20
20	___	9	8
I don't know	___	10	12

4.1.4 A/28. If $y = 15 - x$, what happens to y as x increases?

y increases	___	11	8
y decreases	X	<u>64</u>	<u>74</u>
y remains the same	___	10	6
cannot tell what happens to y.	___	10	5
I don't know	___	6	7

A-25

DOMAIN 4: ALGEBRAIC TOPICS

OBJECTIVE 4.1: EXPRESSIONS, EQUATIONS AND INEQUALITIES

4.1.5 A/39. In factored form, $x^2 - 7x + 12 =$

		p-value gr 10	p-value gr 12
$(x + 4)(x + 3)$	___	4	3
$(x - 4)(x + 3)$	___	9	7
$(x + 4)(x - 3)$	___	5	5
$(x - 4)(x - 3)$	X	<u>68</u>	<u>64</u>
I don't know	___	13	21

4.1.6 A/41. Solve for x and y:

$$x + 2y = 6$$
$$2x - y = 2$$

$x = 4, y = 1$	___	12	8
$x = 2, y = \frac{10}{3}$	___	4	5
$x = 2, y = 2$	X	<u>56</u>	<u>59</u>
$x = \frac{8}{5}, y = \frac{4}{5}$	___	4	3
I don't know	___	23	25

4.1.7 A/45.

> The formula to calculate simple interest is $i = Prt$ where i is the interest, P is the principal, r is the rate, and t is the time in years.

Find the interest on a principal of \$1000 invested for two years at an annual rate of 7%.

\$ 140	X	<u>57</u>	<u>64</u>
\$1400	___	14	11
\$ 70	___	12	11
\$ 14	___	6	5
I don't know	___	11	9

DOMAIN 4: ALGEBRAIC TOPICS

A-26

OBJECTIVE 4.1: EXPRESSIONS, EQUATIONS AND INEQUALITIES

4.1.8 B/7. The equation $2(x + 7) = 2(x + 3) + 8$ is true for:

		p-value gr 10	p-value gr 12
all values of x	X	49	51
no values of x		14	15
only values of x greater than 7		8	8
only values of x less than 7		6	7
I don't know		23	21

4.1.9 B/23. Which expression represents a number that is 9 more than two-thirds of a given number x?

$\frac{2}{3}x + 9$	X	70	67
$\frac{3}{2}x + 9$		3	3
$\frac{2}{3}(x + 9)$		17	16
$\frac{3}{2}(x + 9)$		1	1
I don't know		9	13

4.1.10 B/25. Which of the following describes the solution set of $x + 3 > 6$?

all values of x greater than 6		26	19
all values of x greater than 3	X	63	70
all values of x greater than -2		2	1
all values of x greater than -3		2	2
I don't know		7	7

DOMAIN 4: ALGEBRAIC TOPICS

A-27

OBJECTIVE 4.1: EXPRESSIONS, EQUATIONS AND INEQUALITIES

4.1.11 B/38. $r + s - (r - s) =$

		p-value gr 10	p-value gr 12
0		36	27
$2r + 2s$		14	11
$2r$		5	4
$2s$	X	36	44
I don't know		12	14

4.1.12 B/39. Find the roots of the equation:

$$(x - 1)(x + 7) = 0$$

1, -7	X	45	56
1, 7		6	5
-1, -7		4	5
-1, 7		25	15
I don't know		21	20

4.1.13 B/42. Find the principal, if the interest received after two years at an annual rate of 6% is $60.

> The formula to calculate simple interest is $i = Prt$ where i is the interest, P is the principal, r is the rate, and t is the time in years.

$2000		9	8
$5000		4	6
$ 500	X	35	44
$ 720		20	18
I don't know		32	24

4.1.14 B/44. The cost of a new car is less than 4 times the cost of a used car. If x represents the cost of a new car, and y represents the cost of a used car, which one of these is true?

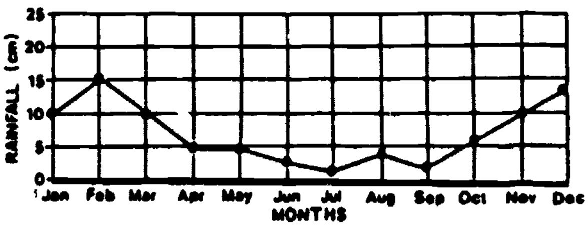
$x < 4y$	X	63	64
$x - y = 4$		4	4
$y > 4x$		16	15
$x = y + 4$		9	6
I don't know		8	11

DOMAIN 4: ALGEBRAIC TOPICS

A-28

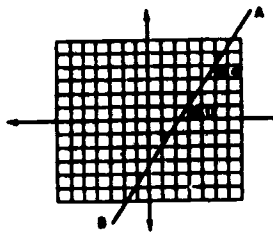
OBJECTIVE 4.2: GRAPHS

4.2.1 A/1. For how many months was the rainfall more than 5 cm?



		p-value gr 10	p-value gr 12
3	___	2	2
4	___	2	2
6	X	90	92
7	___	5	4
I don't know .	___	2	1

4.2.2 A/34. The slope of line AB is:



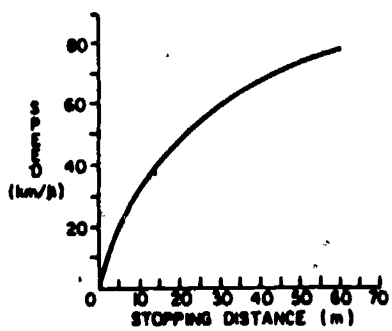
$\frac{3}{2}$	X	32	42
$-\frac{3}{2}$	___	5	5
$\frac{2}{3}$	___	22	21
$-\frac{2}{3}$	___	8	5
I don't know	___	34	27

DOMAIN 4: ALGEBRAIC TOPICS

A-29

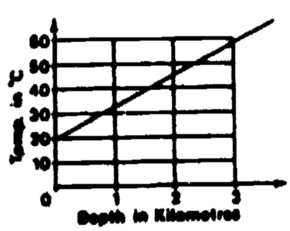
OBJECTIVE 4.2: GRAPHS

4.2.3 A/44. This graph represents the relationship between the speed of a car in kilometres per hour (km/h) and the stopping distance in metres (m) after first applying the brakes. If the skid marks were 45 metres long, about how fast was the car travelling when the brakes were first applied?



		p-value gr 10	p-value gr 12
40 km/h	___	5	4
56 km/h	___	9	7
72 km/h	X	72	75
88 km/h	___	4	4
I don't know	___	10	10

4.2.4 B/1. From the graph below, the temperature at a depth of 2.5 km is closest to:



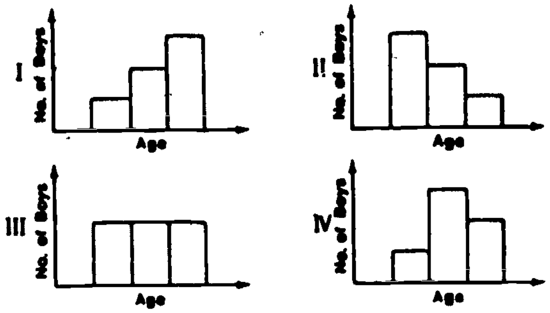
30° C	___	6	4
40° C	___	4	3
50° C	X	84	88
60° C	___	4	3
I don't know	___	2	2

DOMAIN 4: ALGEBRAIC TOPICS

OBJECTIVE 4.2: GRAPHS

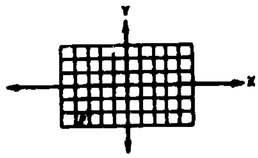
A-30

4.2.5 B/14. Here are the ages of six boys: 10, 9, 9, 8, 8, 8. Which of the following bar graphs represents this information?



		p-value gr 10	p-value gr 12
I		19	21
II	X	68	67
III		3	4
IV		1	2
I don't know		8	6

4.2.6 B/30. The coordinates of point P are:



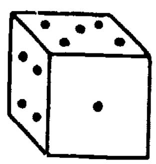
(3, 2)		3	4
(-2, -3)		10	9
(2, 3)		3	3
(-3, -2)	X	76	76
I don't know		7	8

DOMAIN 4: ALGEBRAIC TOPICS

OBJECTIVE 4.3: PROBABILITY *(non-curricular objective)*

A-31

4.3.1 * A/4. If on the roll of a die the probability that a five will appear is 1/6 then the probability that a five <u>or</u> a three will appear is:



		p-value gr 10	p-value gr 12
$\frac{1}{6}$		27	25
$\frac{1}{36}$		3	3
$\frac{1}{3}$	X	53	57
$\frac{1}{12}$		10	9
I don't know		7	6

4.3.2 * A/31. There are 5 pairs of white socks and 3 pairs of black socks in a drawer. The socks have not been paired, they are loose in the drawer. If you reach in without looking, what is the smallest number of socks you must pull out in order to be sure of getting a matched pair?

3	X	52	55
7		16	18
8		18	14
11		6	5
I don't know		9	8

DOMAIN 4: ALGEBRAIC TOPICS

A-32

OBJECTIVE 4.3: PROBABILITY

4.3.3 * A/35. Mike flips 2 quarters. What is the probability that they both land heads?

		p-value gr 10	*p-value* gr 12
$\frac{1}{4}$	X	41	49
$\frac{1}{3}$	___	6	5
$\frac{1}{2}$	___	47	39
$\frac{2}{3}$	___	3	2
I don't know	___	4	5

4.3.4 * B/6. The roof and the body of a car are to be painted different colours. Using only 5 colours, how many different ways can the car be painted?

		gr 10	gr 12
5	___	22	19
9	___	3	4
10	___	28	29
20	X	34	37
I don't know	___	12	11

DOMAIN 4: ALGEBRAIC TOPICS

A-33

OBJECTIVE 4.3: PROBABILITY

4.3.5 * B/33. 2, 3, 4, 4, 5, 6, 8, 8, 9, 10

For a party game each number shown above was painted on a different Ping-Pong ball, and the balls were thoroughly mixed up in a bowl. If a ball is picked from the bowl by a blindfolded person, what is the probability that the ball will have a 4 on it?

		p-value gr 10	*p-value* gr 12
$\frac{1}{2}$	___	2	2
$\frac{1}{4}$	___	10	8
$\frac{1}{5}$	X	63	70
$\frac{1}{10}$	___	21	17
I don't know	___	4	4

4.3.6 * B/37. If the probability that it will rain on a given day is 0.36, then the probability that it will not rain is:

		gr 10	gr 12
0.64	X	53	58
0.36	___	7	5
99.64	___	31	31
99.36	___	1	1
I don't know	___	7	5

DOMAIN 4: ALGEBRAIC TOPICS

A-34

OBJECTIVE 4.4: STATISTICS *(non-curricular objective)*

4.4.1* A/3. The median of the set of numbers {2,2,2,3,4,5,10} is:

		p-value gr 10	gr 12
4	____	18	24
2	____	25	22
3	X	21	26
10	____	3	3
I don't know	____	33	24

4.4.2 *A/16. How many more passengers used the airports in January than in April?

AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers Per Month						Total
	Jan	Feb	Mar	Apr	May	Jun	
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

4	____	60	52
2900	____	1	1
29	____	1	1
400	X	37	45
I don't know	____	1	1

DOMAIN 4: ALGEBRAIC TOPICS

A-35

OBJECTIVE 4.4: STATISTICS

4.4.3 * A/40. The table below shows, for each of four age groups, the number of injuries to pedestrians and the total number of injuries related to motor vehicles which occurred during 1970.

Age Group	Pedestrian Injuries	Total Number Of Injuries
15 - 24	25 000	700 000
25 - 44	20 000	600 000
45 - 64	20 000	350 000
65 - 74	8 000	70 000

According to these statistics, which age group had the fewest number of pedestrian injuries per total number of injuries?

15 - 24	____	16	18
25 - 44	X	14	22
45 - 64	____	6	8
65 - 74	____	60	49
I don't know	____	4	4

4.4.4* B/5. A television commercial states that 90% of the people who expressed a choice thought that Brand A was better or no different than Brand X. What percent of these people could have thought that Brand X was better or no different than Brand A?

less than 10%	____	49	47
up to 100%	X	7	10
at most 90%	____	12	15
cannot tell based on the information	____	29	27
I don't know	____	3	3

A-36

DOMAIN 4: ALGEBRAIC TOPICS

OBJECTIVE 4.4: STATISTICS

4.4.5* B/35.

AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers Per Month						Total
	Jan	Feb	Mar	Apr	May	Jun	
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

How many passengers used the Fiske Airport in June?

		p-value gr. 10	gr. 12
7	____	46	42
26	____	7	7
700	X	40	43
2600	____	5	6
I don't know	____	2	2

4.4.6 * B/36. The mean of the set of numbers {2,2,2,3,4,5,10} is:

3	____	11	13
2	____	33	28
10	____	6	5
4	X	21	30
I don't know	____	28	23

A-37

DOMAIN 5: COMPUTER LITERACY

(non-curricular objective)

OBJECTIVE 5.0

5.0.1 * A/5. At any given moment, a computer's memory unit can store:

		p-value gr. 10	gr. 12
programs	____	2	3
data	____	13	14
answers	____	2	1
all of the above	X	73	75
I don't know	____	9	7

5.0.2 * A/9. For which of the following would people not use a computer?

to find the sum of a column of numbers	____	5	7
to keep track of school records	____	3	3
to decide the winner of a football game	X	77	75
to put a list of names in alphabetical order	____	10	9
I don't know	____	5	6

DOMAIN 5: COMPUTER LITERACY

A-38

OBJECTIVE 5.0

5.0.3 = A/17 In order to program a computer, a person generally:

		p-value gr 10	gr 12
can use any English language words	___	8	5
can use any English or foreign language words	___	5	5
must use numbers, not words	___	10	9
must use a programming language	X	59	67
I don't know	___	17	16

5.0.4 = B/3. A computer program is a:

course on computers	___	31	22
set of instructions to control the computer	X	46	59
computer-generated presentation	___	11	11
piece of computer hardware	___	2	2
I don't know	___	9	7

DOMAIN 5: COMPUTER LITERACY

A-39

OBJECTIVE 5.0

5.0.5 = B/22. The computer-related job closest to that of a typist is:

		p-value gr 10	gr 12
computer operator	___	14	11
systems analyst	___	1	1
keypunch operator	X	47	58
computer programmer	___	26	21
I don't know	___	12	9

5.0.6 = B/28. The main job of a computer programmer is to:

prepare instructions for a computer	X	62	63
operate a computer	___	16	15
schedule jobs for a computer	___	12	14
design computers	___	1	1
I don't know	___	9	7

TQ-ELEM

1-5

Appendix J

SECOND ASSESSMENT OF MATHEMATICS 1981
A QUESTIONNAIRE FOR ELEMENTARY TEACHERS OF MATHEMATICS

The purpose of this questionnaire is to provide information to decision-makers in curriculum, program implementation, teacher training, in-service, resource selection and budget allocation. With the results of this study on hand, these decision-makers will be in a position to make informed judgments about any proposed changes in the system now existing for the teaching and learning of mathematics.

You are asked to respond as fully as you can to these questions. It is recognized that school programs are so varied that some of the questions may not fit the organization or philosophy of your classroom or school. Where there is a lack of congruence between the questions and your situation, please specify and comment.

Please check the appropriate response to each question. For some clearly identified questions, more than one choice may be marked. All other items require only one response. Use the last page if you wish to make detailed comments on any item, or on any aspect of the survey.

A pamphlet which outlines some of the recent activities of the Learning Assessment Branch is included for your information. Many of the services provided have been developed as a consequence of previous assessments.

Province of British Columbia
Ministry of Education
Learning Assessment Branch

A. TEACHER BACKGROUND

1. How many years will you have been teaching mathematics as of June, 1981?

1-2 years	13[1]
3-5 years	17
6-10 years	30
11-15 years	19
More than 15 years	21

2. What percentage of your present school workload is timetabled for the teaching of mathematics?

0-25%	84
26-50%	15
51-75%	1
76-100%	0

3. Which of the following describe(s) your teaching situation? (*Check all that apply.*)

1. Self-contained classroom	80
2. Team teaching	6
3. Open area (2 or more classes)	6
4. Shared workload (one teacher takes all the mathematics, another takes all the language arts, etc.)	11

4. To which of the following associations do you currently belong? (*Check all that apply.*)

1. B.C. Association of Mathematics Teachers	1
2. Provincial Intermediate Teachers Association	15
3. B.C. Primary Teachers Association	28
4. National Council of Teachers of Mathematics	1
5. Local Mathematics P.S.A.	1
6. None of the above	57

[1] Except where otherwise indicated all the numbers reported in this appendix are percentages. All percentages have been rounded to the nearest whole number.

5. How well did each of the following prepare you for the teaching of mathematics?

	Inadequately	Adequately	Very Well
1. Mathematics content courses	25	64	8
2. Mathematics methods courses	30	59	11
3. Other education courses	34	58	7

6. How many years ago did you successfully complete a mathematics content course at the post-secondary level?

I have never successfully completed a mathematics content course at the post-secondary level	16
Less than 2 years ago	6
2-5 years ago	16
6-10 years ago	25
11 or more years ago	37

7. How many years ago did you successfully complete a mathematics methods course at the post-secondary level?

I have never successfully completed a post-secondary mathematics methods course	13
Less than 2 years ago	9
2-5 years ago	16
6-10 years ago	26
11 or more years ago	37

8. Have you attended a mathematics session at a conference in the last three years?

Yes	51
No	49

9. Have you attended a workshop *(other than at a conference)* or an inservice day in mathematics in the last three years?

Yes	54
No	46

10. If you had a choice, would you avoid teaching mathematics altogether?

Yes	2
Undecided	4
No	95

11. If you had a choice, at which grade level would you prefer to teach mathematics?

None	1
Primary/kindergarten	41
Intermediate	55
Junior secondary	3
Senior secondary	1
Post-secondary	0

B. GOALS OF MATHEMATICS EDUCATION

12. How important is each of the following overall goals for school mathematics?

	Not Important	Somewhat Important	Important	Essential
1. To teach students the mathematical concepts and skills required to function as enlightened consumers in a technological society	1	4	30	66
2. To serve as a mechanism for sorting students for entrance into their vocational fields of interest	20	46	30	4
3. To familiarize students with the major ideas and processes used in mathematics	1	13	52	34
4. To prepare students for entry into specialized technological, scientific, and professional fields	6	30	43	21
5. To develop in students the ability to think logically	1	6	39	55
6. To develop students' interest in and enthusiasm for the study of mathematics by introducing them to interesting mathematical topics	2	19	55	24
7. To prepare students for the study of further mathematics	4	31	49	17
8. To develop the idea that mathematics is the science of abstract, deductive structures	24	50	23	3

PROGRAM IMPLEMENTATION

In 1978 the Ministry of Education published the *Mathematics Curriculum Guide, Years One to Twelve.* In the following questions, the words "*Curriculum Guide*" refer to this document.

13. When was the last time you referred to the *Curriculum Guide*?

Within the last 10 days	11
Within the last month	23
Within the last 6 months	33
Within the last year	17
More than a year ago	9
I have never referred to the *Curriculum Guide*	2
I can't recall	6

14. Rate the importance of each of the following in terms of its influence on selecting the content for your mathematics courses.

	Not Applicable	Not Important	Somewhat Important	Important	Essential
1. Textbook	4	10	24	39	24
2. Provincial *Curriculum Guide*	3	6	24	46	21
3. Local curriculum	17	6	17	40	20

15. Various opinions have been expressed about curriculum guides. Check the extent of your agreement or disagreement with each one.

	Strongly Disagree	Disagree	Neutral/ Don't Know	Agree	Strongly Agree
1. No curriculum guide is needed	41	51	4	4	1
2. The format of the current *Curriculum Guide* is adequate as it is	4	25	20	50	2
3. The format of the current *Curriculum Guide* needs to be revised	2	30	31	30	7
4. Topics in a curriculum guide should be listed separately for each grade	1	9	7	59	24
5. A curriculum guide should contain a suggested teaching order for topics for a grade	2	16	7	56	20
6. A curriculum guide should include recommendations for appropriate methods and materials	1	11	9	61	19
7. Time allocations should be suggested for each topic in a curriculum guide	4	27	9	50	10
8. Minimal objectives for each grade should be specified in a curriculum guide	1	7	4	64	25
9. For each grade, a single textbook should be adopted as the basic textbook in mathematics	22	36	8	24	10
10. Any future curriculum guide should be supplemented with one or more resource books	0	4	14	57	25

16. Which one of the following best describes the use in your class of each of the textbooks listed below?
(Respond only for the grade level you teach)

A. GRADES 1-6 TEACHERS	Not Used	Used as a Supplementary Text	Used as a Basic Text
1. *Heath Elementary Mathematics*	46	38	16
2. *Investigating School Mathematics*	8	23	69
3. *Project Mathematics*	72	28	0
4. *Seeing Through Arithmetic*	69	30	1
B. GRADE 7 TEACHERS			
1. *Essentials of Mathematics I*	64	34	2
2. *Mathematics I*	39	36	25
3. *School Mathematics I*	17	15	68
4. *Contemporary Mathematics*	72	26	2
5. *Fundamental Concepts of Elementary Mathematics*	94	5	1

17. Which of the following metric reference materials have you used? *(Check all that apply.)*

1. *A Metric Familiarization Workshop* 24
2. *A Pocket Guide to Metrics* 34
3. *Introduction to the Metric System* 35
4. *Metres, Litres, and Grams* (film) 7
5. *Metric Style Guide* 11
6. *Moving to Metric* (film) 5
7. *Practical Activities for Introducing the Metric System in the Elementary Grades* 23
8. None of the above *(Go to Question 20)* 38

18. Check each of the following which describes your use of the metric reference materials listed in Question 17. *(Check all that apply.)*

1. Used the materials in developing presentations to the class on the metric system 73
2. Used the materials in developing class activities 21
3. Used the materials in developing class handouts 35
4. Students used the materials in individual activities . . . 16
5. Students used the materials in small group activities . . . 37
6. Students were given some of the materials as handouts . . . 21

19. Which of the following best describes how often you used the metric reference material listed in Question 17?

I rarely (1-3 times) use the material 34
I occasionally (4-10 times) use the material 54
I often (10 or more times) use the material 12

20. The current edition of the *Curriculum Guide* lists five major cognitive goals of the mathematics curriculum. Rate these five objectives according to what you consider their importance to be.

The mathematics program will enable the student:	Not Important	Somewhat Important	Important	Essential
1. To identify and use the basic properties and operations of the real number system	0	2	26	72
2. To identify common geometric figures and demonstrate a knowledge of their basic properties	2	37	51	10
3. To transform given numerical and algebraic expressions into equivalent expressions	3	32	54	11
4. To solve open sentences of various types and degrees of complexity	2	21	57	20
5. To apply knowledge of mathematics to familiar physical or environmental situations in order to construct a descriptive mathematical model of the situation or to solve a problem arising from the situation	2	7	40	51

21. In your opinion, how well does this list coincide with your view of what the major cognitive goals of the mathematics curriculum should be?

Not at all 4
Quite well 81
Very well 15

22. Check the highest grade at which some form of mathematics course should be required of all students.

Grade 1	1	Grade 7	1
Grade 2	0	Grade 8	2
Grade 3	0	Grade 9	3
Grade 4	0	Grade 10	19
Grade 5	0	Grade 11	13
Grade 6	0	Grade 12	62

23. At what levels should mathematics be taught by someone who specializes in the teaching of mathematics? (*Check all that apply.*)

1. At no level 1
2. Primary 16
3. Intermediate 32
4. Junior Secondary 88
5. Senior Secondary 85

D. CALCULATOR AND COMPUTER USE

COMPUTER LITERACY, in the following questions, refers to a general awareness of the role and functions of computers in our society. It does not refer to the technical aspects of computing such as programming or data analysis.

24. At which of the following levels do you feel STUDENTS should be allowed to use calculators in their mathematics classes? (*Check all that apply.*)

1. At no level 7
2. Primary 15
3. Intermediate 36
4. Junior Secondary 64
5. Senior Secondary 81

25. If computer literacy were being considered as a topic in the B.C. curriculum, how should the teaching of computer literacy be handled? (*Select one.*)

Computer literacy should NOT be a part of the curriculum . . . 1
It should be taught as part of the mathematics curriculum. . . 24
It should be taught as part of some other existing course (e.g., Business Education). 9
A course in computer literacy should be introduced 28
It should be taught as part of several courses (e.g., Science, Accounting, Mathematics, etc.) 37
Other. 1

26. In your school is there a computer which is used for instructional purposes?

Yes . . . . 12 (*Go to Question 27*)
No . . . . 88 (*Go to Question 30*)

27. Check all the ways in which the computer is used in your school for instructional purposes.

1. A computer is used by a computer club or other extra-curricular group 45
2. A computer is used in some mathematics classes 63
3. A computer is used in a computer science course. 14
4. A computer is used in some classes other than mathematics or computer science. 47

28. Do you use a computer with your mathematics classes?

Yes 9
No . . . . 91 (*Go to Question 30*)

29. Check all the ways in which a computer is used in your mathematics classes.

1. Computer is used as a teaching tool to demonstrate concepts 30
2. Students use the computer for drill and practice 83
3. Students learn computer programming. 33
4. Students use the computer to solve problems that are a normal part of the mathematics course. 27
5. Students use the computer to solve enrichment problems that are an optional part of the mathematics course. . . 63

30. At which level should students be first introduced to computers?

At no level 1
Primary 30
Intermediate 39
Junior Secondary 22
Senior Secondary 9

Items 26 through 30 dealt with the general area of computers.
Items 31 through 35 deal exclusively with MICRO-COMPUTERS.

31. Do you have access to a micro-computer in your school?

Yes 2
No 98

32. Suppose that micro-computers were available for use in your class. With which of the following groups of students would you use them?

All students 75
Only the brighter students 11
Only students needing remediation 2
No students 12

33. Would you be willing to attend workshops on the use of micro-computers?

Yes 83
No 17

34. Which one of the following ways of organizing a workshop on micro-computers do you prefer?

One workshop for your school 18
A series of workshops for your school 47
One workshop for each of the departments (mathematics, English, etc.). 1
A series of workshops for each department (mathematics, English, etc.). 2
A district-wide workshop 8
A district-wide series of workshops. 24

35. Assuming a qualified person is available from the following, who should teach such a workshop? (*Check one only.*)

Personnel from your school 28
Personnel from your district office 30
Personnel from the Ministry of Education 8
Personnel from the universities 14
Personnel from computer distributors 21

E. ASSESSMENT AND TESTING

36. Have you read the following publications concerning the B.C. *Mathematics Assessment* (1977)?

	Yes	No
1. Your District's Interpretation Report.	25	75
2. Provincial Summary Report	24	76
3. Provincial Test Results Report	26	74
4. Provincial Instructional Practices Report . . .	4	96

37. In your school, what impact have the results and recommendations from the previous B.C. *Mathematics Assessment* had on each of the following?

	None	Minimal	Significant	I Don't Know
1. Allocation of personnel	42	8	1	50
2. Provision of inservice.	28	20	6	47
3. Change in curriculum emphasis .	23	20	12	46
4. Change in evaluation practices.	22	21	8	48
5. Provision of supplementary materials	21	23	10	47
6. Improvement of remedial services.	25	20	7	48
7. Improvement of instructional practices	17	22	7	54
8. Increase in time scheduled for mathematics instruction	35	16	3	47

38. Have the results and recommendations from the previous B.C. *Mathematics Assessment* had any impact on your own teaching?

No	65
Yes, minimal impact	30
Yes, significant impact	4

39. The Ministry of Education has produced the following curriculum-based achievement tests. Check all of those which you have used or have ordered for use this year.

1. Grade 3/4 Sets and Numbers	15
2. Grade 3/4 Operations with Whole Numbers	16
3. Grade 3/4 Geometry and Measurement	13
4. Grade 7/8 Sets and Numbers	7
5. Grade 7/8 Operations with Whole Numbers	8
6. Grade 7/8 Operations with Rational Numbers	7
7. Grade 7/8 Geometry and Measurement	7
8. Grade 7/8 Applications	[illegible]

40. Please check which of the following standardized tests in mathematics are used in your class.
(*Check all appropriate responses.*)

1. California Achievement Test	2
2. Canadian Test of Basic Skills	58
3. Comprehensive Test of Basic Skills	4
Iowa Tests of Educational Development	1
5. Key Math	4
6. Metropolitan Achievement Tests	11
7. Sequential Tests of Educational Progress (STEP) . .	0
8. Stanford Achievement Tests	17
9. Stanford Diagnostic Mathematics Tests	7
10. Tests of Academic Progress (TAP)	0
11. Tests accompanying the textbook	42
12. None	21

F. TEACHER EDUCATION OF THE FUTURE

For Questions 41 through 44, assume you have been asked to design the IDEAL teacher education program for future teachers of elementary mathematics. In responding to these questions, please do not feel restricted by existing programs and structures.

41. If you were designing a teacher preparation program for elementary school mathematics teachers for the 1980's, how important would each of the following areas be in that program?

	Not Important	Somewhat Important	Important	Essential
1. Mathematics courses from the department of mathematics	14	38	35	10
2. Mathematics content courses from the Faculty of Education	6	21	45	26
3. Methods of teaching mathematics	0	3	27	69
4. Content courses in other disciplines (e.g., commerce, geography, etc.)	27	44	23	3
5. Foundation courses in education (e.g., philosophy, psychology, sociology, etc.)	26	38	25	9
6. Content courses in English	15	31	37	[illegible]
7. General teaching skills (e.g., classroom management, measurement and evaluation, questioning techniques, etc.)	0	4	28	68
8. Student teaching	1	5	21	72

42. How important would prepara...n in each of the following areas be in your proposed program?

	Not Important	Somewhat Important	Important	Essential
1. Teaching decimals	6	14	38	40
2. Teaching fingermath	38	33	19	4
3. Teaching the four basic operations with whole numbers	1	1	16	81
4. Teaching fractions	5	19	44	32
5. Teaching geometry	2	30	44	19
6. Teaching problem solving	0	2	29	67
7. Teaching metric measurement	1	7	42	51
8. Techniques for classroom management and discipline	1	7	30	61
9. Techniques of diagnosis and remediation	0	4	34	61
10. Knowledge of applications of mathematics	1	10	51	38
11. Knowledge of the structure of mathematics	4	26	47	23
12. Use of stations and laboratories	10	44	35	10

43. What level of importance would you assign to each of the following mathematics content areas in your proposed program?

	Not Important	Somewhat Important	Important	Essential
1. Algebra	13	26	46	16
2. Calculus	38	31	25	6
3. Geometry	3	29	55	13
4. History of Mathematics	38	50	10	2
5. Logic	4	21	48	27
6. Number Theory	2	11	41	46
7. Probability	13	42	40	6
8. Statistics	21	45	31	4

44. What level of importance would you assign to each of the following content courses in other disciplines in your proposed program?

	Not Important	Somewhat Important	Important	Essential
1. Astronomy	30	48	20	2
2. Biology	25	35	35	6
3. Chemistry	22	41	32	6
4. Commerce	15	39	41	6
5. Computer Science	11	28	45	16
6. English	8	16	36	40
7. Engineering	34	41	22	4
8. Geography	18	35	40	8
9. Geology	31	47	20	2
10. Physics	19	39	36	6
11. Psychology	23	33	35	9

G. TEACHER INSERVICE EDUCATION

45. Indicate the degree of help you have received in your teaching of mathematics from each of the following groups who offer inservice activities.

	No Experience With This Group	Not Helpful At All	Somewhat Helpful	Moderately Helpful	Very Helpful	Extremely Helpful
1. Ministry of Education personnel	90	3	5	2	1	0
2. BCTF professional development personnel	68	3	16	8	4	1
3. Local PSA personnel	56	3	17	14	8	3
4. BCAMT workshop speakers	82	3	9	3	3	1
5. University personnel	39	5	19	20	14	4
6. District supervisors, coordinators, or resource teachers	20	6	20	24	21	9
7. Fellow teachers	5	1	15	20	38	22
8. Community resource people	73	5	11	6	5	1
9. Educational consulting firms	83	4	7	4	2	0

46. How important is it to offer an inservice workshop or workshops to elementary mathematics teachers on each of the following topics?

	Not Important	Somewhat Important	Important	Essential
1. Applying mathematics to everyday situations	4	16	51	28
2. Computation with whole numbers	10	21	38	28
3. Computer literacy	13	37	34	14
4. Decimals	11	31	39	16
5. Diagnosis and remediation of learning difficulties in mathematics	1	7	41	50
6. Enrichment topics for elementary school mathematics	1	12	48	39
7. Fractions	12	33	42	12
8. Geometry	8	41	41	8
9. Giftedness	3	25	45	24
10. Metric measurement	3	21	49	26
11. Probability and statistics	25	44	26	4
12. Problem solving	2	10	45	41

47. If you had a choice of inservice format, which one of the following would you prefer?

University course for degree credit	12
Non-credit university course	1
One to two hour workshop on one topic	31
Series of workshops on one topic	29
One day workshop on one topic	27

H. CLASS-SPECIFIC INFORMATION

The questions in this section are meaningful only if answered with a specific class in mind. This class will be identified by answering questions 48 to 50.

48. Do you teach more than one grade of mathematics at the elementary level?

No	69	*(Go to Question 49)*
Yes	31	*(Go to Question 50)*

49. *(If NO to Question 48)* Which one of the following best describes this class?

Grade/Year 1	16
Grade/Year 2	13
Grade/Year 3	16
Grade/Year 4	14
Grade/Year 5	14
Grade/Year 6	13
Grade/Year 7	14

50. *(If YES to Question 48)* The questions in this section are meaningful only if answered with a specific mathematics class in mind. Please identify the one class with which you have had both recent and extensive experience in the teaching of mathematics. If this is not possible, choose the class with which you have had the most recent experience. Note that all of the questions in this section refer to this specific class. Which one of the following best describes the class you have selected?

[If there is more than one grade level represented in your class, please select only one of those grades, preferably the one with the largest enrollment.]

Grade/Year 1	13
Grade/Year 2	14
Grade/Year 3	17
Grade/Year 4	15
Grade/Year 5	12
Grade/Year 6	15
Grade/Year 7	13

51. How does the class you have selected compare with other classes with which you are familiar at this grade level in terms of mathematical ability? The selected class is:

higher in mathematics ability	19
about the same	64
lower in mathematics ability	17

52. In your estimation how wide is the range of mathematics ability in this class?

Very wide	40
Fairly wide	44
Fairly narrow	15
Very narrow	1

53. How many students are enrolled in this class? . . . . ☐☐

Mean is 23.1

54. On the average, how much mathematics instruction does this class receive each 5 day week?

Number of periods . . . . ☐☐

Mean is 5.0

55. What is the average length of each class period (in minutes)?

Number of minutes . . . . ☐☐

Mean is 43.1

56. Which of the following best describes the total amount of time you have for teaching mathematics to this class?

I have more than enough time	4
I have enough time	68
I do not have enough time	28

57. Generally speaking, how frequently during your class instruction time do your students engage in each of the following activities?

	Never	Rarely	Sometimes	Frequently	Very Frequently
1. Oral work	0	1	18	57	25
2. Individual work	1	2	12	44	42
3. Small group work . . .	2	16	43	29	10
4. Solving textbook exercises	3	5	16	46	31
5. Working on creative mathematics projects .	4	34	49	10	2
6. Listening to teacher explanation (demonstration)	0	1	23	59	18
7. Working at activity centres	14	35	34	13	4
8. Drill on arithmetic computation	1	4	19	43	34

Several of the following questions ask for information about the last period you had with this class. While your response for this last period may not be typical of what you usually do, the sum of responses from all teachers will provide a representative picture for the entire province.

58. About how long did it take you to prepare your lesson for the last period you had with this class?

Number of minutes . . . . ☐☐☐

Mean is 17.8

59. About how long did it take you (outside of class) to mark the last homework assignment you gave to this class?

Number of minutes . . . . ☐☐☐

Mean is 26.7

60. Estimate how long it would have taken a student of average ability in this class to complete the last homework assignment you gave.

Number of minutes . . . . ☐☐☐

Mean is 18.7

61. During the last period you had with this class, approximately what percent of the time did you spend on each of the following activities?
(*The total should be 100%.*)

		Mean (%)
1. Large group instruction on a new topic	☐☐☐	20.1
2. Small group instruction on a new topic	☐☐☐	9.6
3. Individual instruction on a new topic	☐☐☐	10.3
4. Supervising seatwork on a new assignment	☐☐☐	22.9
5. Correcting previous assignments	☐☐☐	8.3
6. Giving tests or quizzes	☐☐☐	6.4
7. Reviewing previously taught material	☐☐☐	15.1
8. Other	☐☐☐	4.9
TOTAL	1 0 0	

62. Which one of the following describes the major use you make of the textbook(s) in this class?

To develop a new concept	10
To review concepts developed in class	15
To provide exercises for drill and practice	75

63. How important is each of the following techniques of evaluation of student mathematics achievement in this class?

	Not Important	Somewhat Important	Important	Essential
1. Teacher observations of students' performance	0	4	35	61
2. Teacher-prepared tests	1	10	53	36
3. Tests prepared by school personnel	41	40	18	1
4. Tests prepared by district office personnel	44	38	17	2
5. Ministry supplied classroom achievement tests	39	42	18	1
6. Tests accompanying mathematics series	21	33	40	6
7. Commercially-produced standardized tests	41	43	15	1

64. If some students are unsuccessful in fulfilling the mathematics requirements for this class, what should the policy be for them?
(*Check the one best response only.*) They should:

go to a special class within the school for remedial work	75
go to a special school for remedial work	1
proceed to the next higher grade level with their classmates	16
repeat the course	9
repeat the entire grade	0

65. With respect to this class, the present prescribed curriculum meets the needs of my students:

very well	14
adequately	77
inadequately	9
not at all	1

The following opinions have been expressed about mathematics curricula in general. Indicate the extent of your agreement or disagreement with each statement as far as this class is concerned.

	Strongly Disagree	Disagree	Neutral/ Don't Know	Agree	Strongly Agree
1. Logical structure should be emphasized as a framework for the study of mathematics	0	2	19	60	19
2. Opportunity must be provided for studen)apply mathemat as wide a realm as .. sible	0	2	4	67	27
3. Instructional units dealing with statistics should be included in the curriculum	7	25	45	21	1
4. Problem solving should be the focus of school mathematics in the 1980's	1	13	16	53	17
5. Basic skills in mathematics should be defined to encompass more than computational facility	1	5	13	61	19

67. Below is a list of twelve topic areas which might be included in any mathematics curriculum. To what extent is each one emphasized in the current curriculum for this class?

	No Emphasis	Little Emphasis	Some Emphasis	Much Emphasis
1. Mathematical concepts	0	2	29	69
2. Arithmetic skills	0	1	9	91
3. Algebraic concepts and skills	20	32	42	7
4. Geometric concepts	2	28	66	5
5. Consumer mathematics	20	40	36	4
6. Applications to other fields	18	42	37	3
7. Structure of number systems and properties	5	19	50	26
8. Measurement	0	10	66	24
9. Problem solving	1	6	47	47
10. Logical thinking	2	18	53	27
11. Using mathematics to predict	14	44	36	6
12. Reading, interpreting, and constructing tables and graphs	6	31	53	9

68. To what extent do you feel each of the same twelve topics should be emphasized in the mathematics curriculum for the level you are currently teaching?

	No Emphasis	Little Emphasis	Some Emphasis	Much Emphasis
1. Mathematical concepts	0	2	24	73
2. Arithmetic skills	0	1	7	92
3. Algebraic concepts and skills	17	26	46	9
4. Geometric concepts	2	22	67	8
5. Consumer mathematics	10	20	49	20
6. Applications to other fields	7	26	53	13
7. Structure of number systems and properties	4	16	48	30
8. Measurement	0	4	58	38
9. Problem solving	0	1	28	70
10. Logical thinking	1	7	41	50
11. Using mathematics to predict	7	25	51	16
12. Reading, interpreting, and constructing tables and graphs	3	16	60	21

69. In which of the following ways are students in this class allowed to use calculators for mathematics? (*Check all that apply.*)

1. Students do not use hand-held calculators in my mathematics class	86
2. Unrestricted use	2
3. To check work	12
4. To shorten computation time and effort in class work	3
5. To shorten computation time and effort on tests	0
6. To shorten computation time and effort on assignments	3

70. In which of the following ways do you make use of calculators with this class? (*Check all that apply.*)

1. I do not use calculators in this class	87
2. To do the computation so the concept can be emphasized	4
3. To do the computation so many more examples of a concept may be shown	4
4. To show students how to use calculators	10

1. Please use this space to make any other comments on the mathematics program in your school.

TQ-SEC

1-5

Appendix

SECOND ASSESSMENT OF MATHEMATICS 1981
A QUESTIONNAIRE FOR SECONDARY TEACHERS OF MATHEMATICS

The purpose of this questionnaire is to provide information to decision-makers in curriculum, program implementation, teacher training, in-service, resource selection and budget allocation. With the results of this study on hand, these decision-makers will be in a position to make informed judgments about any proposed changes in the system now existing for the teaching and learning of mathematics.

You are asked to respond as fully as you can to these questions. It is recognized that school programs are so varied that some of the questions may not fit the organization or philosophy of your classroom or school. Where there is a lack of congruence between the questions and your situation, please specify and comment.

Please check the appropriate response to each question. For some clearly identified questions, more than one choice may be marked. All other items require only one response. Use the last page if you wish to make detailed comments on any item, or on any aspect of the survey.

A pamphlet which outlines some of the recent activities of the Learning Assessment Branch is included for your information. Many of the services provided have been developed as a consequence of previous assessments.

Province of British Columbia
Ministry of Education
Learning Assessment Branch

A. TEACHER BACKGROUND

1. How many years will you have been teaching mathematics as of June, 1981?

1-2 years	16[1]
3-5 years	20
6-10 years	23
11-15 years	18
More than 15 years	24

2. What percentage of your present school workload (including spares and administrative duties) is timetabled for the teaching of mathematics?

0-25%	30
26-50%	18
51-75%	12
76-100%	41

3. To which of the following associations do you currently belong? (*Check all that apply.*)

1.	B.C. Association of Mathematics Teachers	26
2.	Provincial Intermediate Teachers Association	0
3.	B.C. Computers in Education Committee	4
4.	National Council of Teachers of Mathematics	14
5.	Local Mathematics P.S.A.	21
6.	None of the above	59

[1] Except where otherwise indicated all the numbers reported in this appendix are percentages. All percentages have been rounded to the nearest whole number.

APPENDIX J

TEACHER QUESTIONNAIRE (SECONDARY)

4. How many university/college courses have you successfully completed in each of the following subjects? (One course = 1.5 units = 3 semester hours = 4.5 quarter hours; select *"Less than one"* if, for instance, "Methods of Teaching Mathematics" was taught as part of a general Teaching Methods Course.

	None	Less Than One	One	Two	Three Or More
1. Algebra	20	3	18	17	42
2. Astronomy	86	4	6	3	1
3. Biology	50	2	19	8	21
4. Calculus	19	2	16	22	40
5. Chemistry	31	1	17	19	31
6. Commerce	82	1	7	4	5
7. Computer Science	61	6	15	12	6
8. Engineering	87	1	3	1	8
9. Geography	70	2	12	7	10
10. Geology	68	3	19	7	4
11. Geometry	44	5	25	16	10
12. History of Mathematics	81	8	9	2	0
13. Logic	69	9	16	5	2
14. Methods of Teaching Mathematics	33	14	35	12	6
15. Number Theory	55	6	25	11	3
16. Physics	32	2	19	18	30
17. Probability	51	11	24	10	4
18. Statistics	31	11	35	15	8

5. How well did each of the following prepare you for the teaching of mathematics?

	Inadequately	Adequately	Very Well
1. Mathematics content courses	17	51	32
2. Mathematics methods courses	38	52	10
3. Other education courses	40	54	6

6. How many years ago did you successfully complete a mathematics <u>content</u> course at the post-secondary level?

I have never successfully completed a mathematics content course at the post-secondary level	10
Less than 2 years ago	6
2-5 years ago	13
6-10 years ago	28
11 or more years ago	43

7. How many years ago did you successfully complete a mathematics <u>methods</u> course at the post-secondary level?

I have never successfully completed a post-secondary mathematics methods course	28
Less than 2 years ago	4
2-5 years ago	10
6-10 years ago	21
11 or more years ago	37

8. Have you attended a mathematics session at a conference in the last three years?

Yes	57
No	43

9. Have you attended a workshop *(other than at a conference)* or an inservice day in mathematics in the last three years?

Yes	58
No	42

10. If you had a choice, would you avoid teaching mathematics altogether?

Yes	5
Undecided	5
No	90

11. If you had a choice, at which grade level would you prefer to teach mathematics?

None	4
Primary/kindergarten	0
Intermediate	2
Junior secondary	38
Senior secondary	51
Post-secondary	5

B. GOALS OF MATHEMATICS EDUCATION

12. How important is each of the following overall goals for school mathematics?

	Not Important	Somewhat Important	Important	Essential
1. To teach students the mathematical concepts and skills required to function as enlightened consumers in a technological society	1	7	31	61
2. To serve as a mechanism for sorting students for entrance into their vocational fields of interest	15	48	35	3
3. To familiarize students with the major ideas and processes used in mathematics	1	21	58	20
4. To prepare students for entry into specialized technological, scientific, and professional fields	3	20	54	23
5. To develop in students the ability to think logically	1	8	49	42
6. To develop students' interest in and enthusiasm for the study of mathematics by introducing them to interesting mathematical topics	3	34	52	11
7. To prepare students for the study of further mathematics	4	27	51	18
8. To develop the idea that mathematics is the science of abstract, deductive structures	29	48	20	3

C. PROGRAM IMPLEMENTATION

In 1978 the Ministry of Education published the *Mathematics Curriculum Guide, Years One to Twelve*. In the following questions, the words "*Curriculum Guide*" refer to this document.

13. When was the last time you referred to the *Curriculum Guide*?

Within the last 10 days	22
Within the last month	23
Within the last 6 months	26
Within the last year	15
More than a year ago	7
I have never referred to the *Curriculum Guide*	5
I can't recall	2

14. Rate the importance of each of the following in terms of its influence on selecting the content for your mathematics courses.

	Not Applicable	Not Important	Somewhat Important	Important	Essential
1. Textbook	5	14	21	42	19
2. Provincial *Curriculum Guide*	3	4	22	45	26
3. Local curriculum	20	5	19	36	19

15. Various opinions have been expressed about curriculum guides. Check the extent of your agreement or disagreement with each one.

	Strongly Disagree	Disagree	Neutral/ Don't Know	Agree	Strongly Agree
1. No curriculum guide is needed	48	42	4	4	2
2. The format of the current *Curriculum Guide* is adequate as it is	6	26	24	42	2
3. The format of the current *Curriculum Guide* needs to be revised	2	27	31	32	9
4. Topics in a curriculum guide should be listed separately for each grade	1	10	15	59	15
5. A curriculum guide should contain a suggested teaching order for topics for a grade	2	19	10	56	14
6. A curriculum guide should include recommendations for appropriate methods and materials	1	12	13	59	15
7. Time allocations should be suggested for each topic in a curriculum guide	1	14	10	55	11
8. Minimal objectives for each grade should be specified in a curriculum guide	1	3	5	65	26
9. For each grade, a single textbook should be adopted as the basic textbook in mathematics	15	35	11	26	13
10. Any future curriculum guide should be supplemented with one or more resource books	1	2	14	57	27

16. For each of the mathematics courses you teach, which one of the following best describes your use of each of the textbooks listed below? (*Respond only for courses you teach*)

A. MATHEMATICS 8	Not Used	Used as a Supplementary or Resource Text	Used as a Basic Text
1. *Essentials of Mathematics 2*	63	30	7
2. *Mathematics II*	33	27	40
3. *School Mathematics 2*	33	33	35
4. *Contemporary Mathematics*	90	10	0
5. *Fundamental Concepts of Elementary Mathematics*	94	5	1

B. MATHEMATICS 9	Not Used	Used as a Supplementary or Resource Text	Used as a Basic Text
1. *Essentials of Mathematics 3*	8'	15	3
2. *Mathematical Pursuits, One*	31	19	1
3. *Mathematics for a Modern World, Book 1*	21	20	60
4. *Modern Algebra, Book 1 Modules 1, 2, 3*	35	36	29
5. *Trouble-Shooting Mathematics Skills*	54	36	10

C. MATHEMATICS 10	Not Used	Used as a Supplementary or Resource Text	Used as a Basic Text
. *Business and Consumer Mathematics*	55	24	22
.. *Career Mathematics, Industry and Trade*	68	21	11
3. *Mathematical Pursuits, Two*	81	19	0
4. *Mathematics for a Modern World, Book 2*	25	20	56
5. *Modern Algebra, Book 1 Modules 4, 5, 6*	41	30	29
6. *Trouble-Shooting Mathematics Skills*	70	25	4

16. Con't.

	Not Used	Used as a Supplementary or Resource Text	Used as a Basic Text
D. ALGEBRA 11			
1. *Mathematics for a Modern World 1112*	66	29	6
2. *Modern Algebra and Trigonometry, Book 2*	27	50	23
3. *Using Advanced Algebra*	10	14	76
E. CONSUMER MATHEMATICS 11			
1. *Business and Consumer Mathematics*	39	24	38
2. *Contemporary Business Mathematics*	43	22	35
F. TRADES MATHEMATICS 11			
1. *Basic Mathematics Simplified*	30	19	52
2. *Practical Problems in Mathematics Series* (Any or all 6 modules)	46	37	17
G. ALGEBRA 12			
1. *Introduction to Calculus*	69	20	11
2. *Mathematics for a Modern World 1112*	76	23	2
3. *Modern Algebra and Trigonometry, Book 2*	20	36	44
4. *Pre-Calculus Mathematics*	52	35	13
5. *Using Advanced Algebra*	20	20	61
H. GEOMETRY 12			
1. *Geometry* (B.C. *Metric Edition*)	57	20	24
I. PROBABILITY & STATISTICS 12			
1. *Probability and Statistics*	58	24	19

17. Which of the following metric reference materials have you used? (*Check all that apply.*)

1. A *Metric Familiarization Workshop* 9
2. A *Pocket Guide to Metrics* 23
3. *Introduction to the Metric System* 18
4. *Metres, Litres, and Grams* (film) 2
5. *Metric Style Guide* 17
6. *Moving to Metric* (film) 2
7. *Practical Activities for Introducing the Metric System in the Elementary Grades* 2
8. None of the above (*Go to Question 20*) 59

18. Check each of the following which describes your use of the metric reference materials listed in Question 17. (*Check all that apply.*)

1. Used the materials in developing presentations to the class on the metric system 72
2. Used the materials in developing class activities 39
3. Used the materials in developing class handouts 36
4. Students used the materials in individual activities 20
5. Students used the materials in small group activities 13
6. Students were given some of the materials as handouts 33

19. Which of the following best describes how often you used the metric reference material listed in Question 17?

I rarely (1-3 times) use the material 52
I occasionally (4-10 times) use the material 37
I often (10 or more times) use the material 11

20. The current edition of the *Curriculum Guide* lists five major cognitive goals of the mathematics curriculum. Rate these five objectives according to what you consider their importance to be.

The mathematics program will enable the student:	Not Important	Somewhat Important	Important	Essential
1. To identify and use the basic properties and operations of the real number system	1	7	35	57
2. To identify common geometric figures and demonstrate a knowledge of their basic properties	1	21	57	21
3. To transform given numerical and algebraic expressions into equivalent expressions	1	17	58	24
4. To solve open sentences of various types and degrees of complexity	1	14	58	27
5. To apply knowledge of mathematics to familiar physical or environmental situations in order to construct a descriptive mathematical model of the situation or to solve a problem arising from the situation	1	11	44	44

21. In your opinion, how well does the above list coincide with your view of what the major cognitive goals of the mathematics curriculum should be?

Not at all	4
Quite well	79
Very well	18

22. Various ways of organizing the secondary program in mathematics have been suggested. Which one of the following seems to you to be the most appropriate organization? Respond for both the junior and senior secondary levels.

	1. Junior Secondary	2. Senior Secondary
All students follow the same mathematics program and are assigned to classes according to ability	29	9
All students follow the same basic program but are not assigned to classes according to ability	13	5
Students follow different programs or courses and are assigned to classes according to ability or interest	58	86

23. Check the highest grade at which you feel some form of mathematics course should be required of all students.

Grade 1	0	Grade 7	0
Grade 2	0	Grade 8	3
Grade 3	0	Grade 9	3
Grade 4	0	Grade 10	27
Grade 5	0	Grade 11	40
Grade 6	0	Grade 12	27

24. At what levels should mathematics be taught by specialists? (*Check all that apply.*)

1. At no level 3
2. Primary 25
3. Intermediate 47
4. Junior Secondary 77
5. Senior Secondary 93

D. CALCULATOR AND COMPUTER USE

> *COMPUTER LITERACY, in the following questions, refers to a general awareness of the role and functions of computers in our society. It does not refer to the technical aspects of computing such as programming or data analysis.*

25. At which of the following levels do you feel students should be allowed to use calculators in their mathematics classes? (*Check all that apply.*)

1. At no level 5
2. Primary 10
3. Intermediate 20
4. Junior Secondary 56
5. Senior Secondary 91

26. If computer literacy were being considered as a topic in the B.C. curriculum, how should the teaching of computer literacy be handled? (*Select one.*)

- Computer literacy should not be a part of the curriculum . . . 2
- It should be taught as part of the mathematics curriculum. . . 20
- It should be taught as part of some other existing course (e.g., Business Education). 5
- A course in computer literacy should be introduced 32
- It should be taught as part of several courses (e.g., Science, Accounting, Mathematics, etc.) 41
- Other. 2

27. In your school is there a computer which is used for instructional purposes?

- Yes . . . . 61 (*Go to Question 28*)
- No . . . . 39 (*Go to Question 31*)

28. Check all the ways in which the computer is used in your school for instructional purposes.

1. A computer is used by a computer club or other extra-curricular group 62
2. A computer is used in some mathematics classes 64
3. A computer is used in a computer science course. 68
4. A computer is used in some classes other than mathematics or computer science. 43

29. Do you use a computer with your mathematics classes (excluding Computer Science courses)?

- Yes 28
- No . . . . 72 (*Go to Question 31*)

30. Check all the ways in which a computer is used in your mathematics (excluding Computer Science courses).

1. Computer is used as a teaching tool to demonstrate concepts 45
2. Students use the computer for drill and practice 30
3. Students learn computer programming. 68
4. Students use the computer to solve problems that are a normal part of the mathematics c[illegible] 37
5. Students use the computer to solve enric[illegible] problems [illegible]re an optional part of the mathematics course. . . 33

31. At which level should students be first introduced to computers?

- At no level 0
- Primary 17
- Intermediate 32
- Junior Secondary 42
- Senior Secondary 9

Items 27 through 31 dealt with the general area of computers.
Items 32 through 36 deal exclusively with MICRO-COMPUTERS.

32. Do you have access to a micro-computer in your school?

Yes	52
No	48

33. Suppose that micro-computers were available for use in your class. With which of the following groups of students would you use them?

All students	85
Only the brighter students	9
Only students needing remediation	2
No students	5

34. Would you be willing to attend workshops on the use of micro-computers?

Yes	95
No	5

35. Which one of the following ways of organizing a workshop on micro-computers do you prefer?

One workshop for your school	8
A series of workshops for your school	33
One workshop for each of the departments (mathematics, English, etc.)	5
A series of workshops for each department (mathematics, English, etc.)	27
A district-wide workshop	5
A district-wide series of workshops	22

36. Assuming a qualified person is available from the following, who should teach such a workshop? (*Check one only.*)

Personnel from your school	43
Personnel from your district office	15
Personnel from the Ministry of Education	11
Personnel from the universities	15
Personnel from computer distributors	17

E. ASSESSMENT AND TESTING

37. Have you read the following publications concerning the B.C. *Mathematics Assessment* (1977)?

	Yes	No
1. Your District's Interpretation Report	38	62
2. Provincial Summary Report	41	59
3. Provincial Test Results Report	39	61
4. Provincial Instructional Practices Report	16	84

38. In your school, what impact have the results and recommendations from the previous B.C. *Mathematics Assessment* had on each of the following?

	None	Minimal	Significant	I Don't Know
1. Allocation of personnel	33	14	3	50
2. Provision of inservice	29	20	3	49
3. Change in curriculum emphasis	16	26	16	43
4. Change in evaluation practices	23	25	8	44
5. Provision of supplementary materials	24	24	7	45
6. Improvement of remedial services	22	19	15	45
7. Improvement of instructional practices	18	24	8	50
8. Increase in time scheduled for mathematics instruction	39	12	9	40

39. Have the results and recommendations from the previous B.C. *Mathematics Assessment* had any impact on your own teaching?

No	57
Yes, minimal impact	38
Yes, significant impact	6

40. The Ministry of Education has produced the following curriculum-based achievement tests. Check all of those which you have used or have ordered for use this year.

1. Grade 7/8	Sets and Numbers	16
2. Grade 7/8	Operations with Whole Numbers	19
3. Grade 7/8	Operations with Rational Numbers	18
4. Grade 7/8	Geometry and Measurement	16
5. Grade 7/8	Applications	16
6. Grade 10/11	Algebra	24
7. Grade 10/11	Geometry and Measurement	19
8. Grade 10/11	Consumer Mathematics	19
9. Algebra 11		18
10. Algebra 12 (*BCAMT Version*)		12
11. Algebra 12 (*Revised*)		12

41. Please check which of the following standardized tests in mathematics are used in your class.
(*Check all appropriate responses.*)

1. California Achievement Test	1
2. Canadian Test of Basic Skills	13
3. Comprehensive Test of Basic Skills	2
4. Iowa Tests of Educational Development	1
5. Key Math	2
6. Metropolitan Achievement Tests	2
7. Sequential Tests of Educational Progress (STEP)	1
8. Stanford Achievement Tests	6
9. Stanford Diagnostic Mathematics Tests	8
10. Tests of Academic Progress (TAP)	1
11. Tests accompanying the textbooks	25
12. None	57

42. Do you feel that an examination in mathematics (analogous to the English Placement Test) should be used to determine placement in university?

Yes	53
No	47

F. TEACHER EDUCATION OF THE FUTURE

For Questions 43 through 46, assume you have been asked to design the IDEAL teacher education program for future teachers of secondary mathematics. In responding to these questions, please do not feel restricted by existing programs and structures.

43. If you were designing a teacher preparation program for secondary school mathematics teachers for the 1980's, how important would each of the following areas be in that program?

	Not Important	Somewhat Important	Important	Essential
1. Mathematics courses from the department of mathematics	2	15	41	42
2. Mathematics content courses from the Faculty of Education	18	23	41	18
3. Methods of teaching mathematics	2	13	37	48
4. Content courses in other disciplines (e.g., commerce, geography, etc.)	15	48	32	5
5. Foundation courses in education (e.g., philosophy, psychology, sociology, etc.)	29	46	19	5
6. Content courses in English	13	40	38	10
7. General teaching skills (e.g., classroom management, measurement and evaluation, questioning techniques, etc.)	1	9	35	55
8. Student teaching	1	5	23	71

44. How important would preparation in each of the following areas be in your proposed program?

	Not Important	Somewhat Important	Important	Essential
1. Teaching algebra	0	5	43	52
2. Teaching consumer mathematics	1	14	49	36
3. Teaching geometry	1	15	53	31
4. Teaching metric measurement	7	25	43	25
5. Teaching probability and statistics	7	45	38	9
6. Teaching problem solving	0	3	36	60
7. Teaching trade and industrial mathematics	3	31	50	17
8. Teaching applications of mathematics	0	11	51	38
9. Teaching the structure of mathematics	7	43	38	12
10. Techniques of classroom management and discipline	2	10	32	57
11. Techniques of evaluation	2	12	45	42
12. Techniques of diagnosis and remediation	1	11	41	48

45. What level of importance would you assign to each of the following mathematics content areas in your proposed program?

	Not Important	Somewhat Important	Important	Essential
1. Algebra	1	4	36	60
2. Calculus	14	37	36	13
3. Geometry	:	14	53	32
4. History of Mathematics	29	52	16	3
5. Logic	5	39	42	15
6. Number Theory	3	30	48	19
7. Probability	6	54	37	4
8. Statistics	5	49	40	6

46. What level of importance would you assign to each of the following content courses in other disciplines in your proposed program?

	Not Important	Somewhat Important	Important	Essential
1. Astronomy	22	52	19	2
2. Biology	30	46	21	3
3. Chemistry	12	46	37	4
4. Commerce	7	45	43	5
5. Computer Science	1	17	54	28
6. English	10	27	40	23
7. Engineering	19	45	30	6
8. Geography	30	52	17	1
9. Geology	36	51	12	1
10. Physics	5	32	52	12
11 Psychology	30	44	23	4

G. TEACHER INSERVICE EDUCATION

47. Indicate the degree of help you have received in your teaching of mathematics from each of the following groups who offer inservice activities.

		No Experience With This Group	Not Helpful At All	Somewhat Helpful	Moderately Helpful	Very Helpful	Extremely Helpful
1.	Ministry of Education personnel	81	7	8	3	1	0
2.	BCTF professional development personnel	68	5	15	8	3	1
3.	Local PSA personnel	49	6	22	14	7	2
4.	BCAMT workshop speakers	58	4	16	12	9	2
5.	University personnel	46	7	20	18	8	2
6.	District supervisors, coordinators, or resource teachers	38	14	21	17	8	2
	Fellow teachers	1	1	10	21	40	27
	Community resource people	69	7	15	6	3	0
9.	Educational consulting firms	84	6	7	3	1	0

48. How important is it to offer an inservice workshop or workshops to secondary mathematics teachers on each of the following topics?

		Not Important	Somewhat Important	Important	Essential
1.	Applying mathematics to everyday situations	5	19	49	27
2.	Calculus	35	45	17	3
3.	Computer literacy	3	20	47	30
4.	Consumer mathematics	4	27	52	18
5.	Diagnosis and remediation	5	22	47	27
6.	Enrichment topics for secondary school mathematics	3	25	54	18
7.	Giftedness	5	34	44	17
8.	Metric measurement	19	41	30	10
9.	Probability and statistics	14	54	28	3
10.	Problem solving	4	13	52	31
11.	Topics in algebra	6	26	52	16
12.	Topics in geometry	6	33	50	12
13.	Use of micro-computers	3	17	50	31
14.	Vocational or career mathematics	4	29	50	17

49. If you had a choice of inservice format, which one of the following would you prefer?

University course for degree credit	17
Non-credit university course	3
One to two hour workshop on one topic	20
Series of workshops on one topic	34
One day workshop on one topic	26
Other	2

H. CLASS-SPECIFIC INFORMATION

50. The questions in this section are meaningful only if answered with a specific mathematics class in mind. Please identify the one class with which you have had both recent and extensive experience in the teaching of mathematics. If this is not possible, choose the class with which you have had the most recent experience. Note that all of the questions in this section refer to this specific class.

Which one of the following best describes the class you have selected?

Mathematics 8	23
Mathematics 9	21
Mathematics 10	23
Algebra 11	14
Consumer mathematics 11	5
Trades mathematics 11	3
Computer science 11	0
Geometry 12	1
Probability and statistics 12	1
Algebra 12	10

51. How does the class you have selected compare with other classes at this grade level in terms of mathematical ability? The selected class is.

higher in mathematics ability	23
about the same	51
lower in mathematics ability	27

52. In your estimation how wide is the range of mathematics ability in this class?

Very wide	36
Fairly wide	45
Fairly narrow	16
Very narrow	2

53. How many students are enrolled in this class?

Mean is 26.7

54. Generally speaking, how frequently during your class instruction time do your students engage in each of the following activities?

	Never	Rarely	Sometimes	Frequently	Very Frequently
1. Oral work	1	7	38	47	9
2. Individual work	0	4	6	47	44
3. Small group work	11	34	34	17	3
4. Solving textbook exercises	1	2	9	47	41
5. Working on creative mathematics projects	24	44	28	3	1
6. Listening to teacher explanation (demonstration)	0	1	17	65	17
7. Working at activity centres	69	24	5	1	0
8. Drill on arithmetic computation	22	24	33	16	6

Several of the following questions ask for information about the last period you had with this class. While your response for this last period may not be typical of what you usually do, the sum of responses from all teachers will provide a representative picture for the entire province.

55. About how long did it take you to prepare your lesson for the last period you had with this class?

Number of minutes

Mean is 24.2

56. About how long did it take you (outside of class) to mark the last homework assignment you gave to this class?

Number of minutes

Mean is 43.0

57. Estimate how long it would have taken a student of average ability in this class to complete the last homework assignment you gave.

Number of minutes

Mean is 30.0

58. During the last period you had with this class, approximately what percent of the time did you spend on each of the following activities? (*The total should be 100%.*)

	Mean (%)
1. Large group instruction on a new topic	23.1
2. Small group instruction on a new topic	3.5
3. Individual instruction on a new topic	10.9
4. Supervising seatwork on a new assignment	25.9
5. Correcting previous assignments	8.8
6. Giving tests or quizzes	8.2
7. Reviewing previously taught material	14.3
8. Other	3.7
TOTAL	100

59. Which one of the following describes the major use you make of the textbook(s) in this class?

To develop a new concept	5
To review concepts developed in class	7
To provide exercises for drill and practice	87

60. How important is each of the following techniques of evaluation of student mathematics achievement in this class?

	Not Important	Somewhat Important	Important	Essential
1. Teacher observations of students' performance	7	30	45	19
2. Teacher-prepared tests	0	2	38	60
3. Tests prepared by school personnel	37	30	28	6
4. Tests prepared by district office personnel	67	25	8	1
5. Ministry supplied classroom achievement tests	54	32	12	2
6. Tests accompanying mathematics series	55	27	17	2
7. Commercially-produced standardized tests	72	23	4	1

61. If some students are unsuccessful in fulfilling the mathematics requirements for this class, what should the policy be for them? (*Check the one best response only.*) They should:

not be permitted to take any more mathematics courses	1
take a different mathematics course at the same grade level	28
go to a special class within the school for remedial work	17
go to a special school for remedial work	1
proceed to the next higher mathematics course with their classmates	1
proceed to the next higher grade level with their classmates	4
repeat the course	49
repeat the entire grade	0

62. With respect to this class, the present prescribed curriculum meets the needs of my students:

very well	16
adequately	68
inadequately	15
not at all	2

63. The following opinions have been expressed about mathematics curricula in general. Indicate the extent of your agreement or disagreement with each statement as far as this class is concerned.

	Strongly Disagree	Disagree	Neutral/ Don't Know	Agree	Strongly Agree
1. Logical structure should be emphasized as a framework for the study of mathematics	1	5	17	59	19
2. Opportunity must be provided for students to apply mathematics in as wide a realm as possible	0	2	9	65	25
3. Instructional units dealing with statistics should be included in the curriculum	3	17	34	41	6
4. Problem solving should be the focus of school mathematics in the 1980's	0	8	16	50	25
5. Basic skills in mathematics should be defined to encompass more than computational facility	0	4	13	62	21

64. Below is a list of twelve topic areas which might be included in any mathematics curriculum. To what extent is each one emphasized in the current curriculum for this class?

	No Emphasis	Little Emphasis	Some Emphasis	Much Emphasis
1. Mathematical concepts	0	5	47	48
2. Arithmetic skills	2	16	40	41
3. Algebraic concepts and skills	2	10	26	62
4. Geometric concepts	7	23	56	15
5. Consumer mathematics	17	36	33	13
6. Applications to other fields	10	42	41	7
7. Structure of number systems and properties	9	33	43	15
8. Measurement	11	36	43	9
9. Problem solving	0	5	49	46
10. Logical thinking	2	20	50	28
11. Using mathematics to predict	20	50	27	3
12. Reading, interpreting, and constructing tables and graphs	6	31	49	13

65. To what extent do you feel each of the same twelve topics should be emphasized in the mathematics curriculum for the secondary level you are currently teaching?

	No Emphasis	Little Emphasis	Some Emphasis	Much Emphasis
1. Mathematical concepts	0	4	43	53
2. Arithmetic skills	3	9	39	50
3. Algebraic concepts and skills	2	6	30	63
4. Geometric concepts	2	11	6[illegible]	27
5. Consumer mathematics	6	16	49	[illegible]
6. Applications to other fields	2	16	61	22
7. Structure of number systems and properties	6	31	49	15
8. Measurement	5	23	54	19
9. Problem solving	0	2	3[illegible]	64
10. Logical thinking	[illegible]	9	45	45
11. Using mathematics to predict	6	[illegible]	55	13
12. Reading, interpreting, and constructing tables and graphs	1	16	[illegible]	23

66. In which of the following ways are students in this class allowed to use calculators for mathematics? *(Check all that apply.)*

1. Students do not use hand-held calculators in my mathematics class . . . 38
2. Unrestricted use . . . 17
3. To check work . . . 30
4. To shorten computation time and effort in class work . . . 46
5. To shorten computation time and effort on tests . . . 22
6. To shorten computation time and effort on assignments . . . 45

67. In which of the following ways do you make use of calculators with this class? *(Check all that apply.)*

1. I do not use calculators in this class . . . 49
2. To do the computation so the concept can be emphasized . . . 35
3. To do the computation so many more examples of a concept may be shown . . . 36
4. To show students how to use calculators . . . 23

68. Please use this space to make any other comments on the mathematics program in your school.